Building with minimum impact – **Redevelopment of Research Facilities on Heron Island**

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Thesis submitted in partial fulfilment of the requirements for the
Master of Philosophy (by Design),
Supervised by Kathi Holt-Damant,
The Department of Architecture,
The University of Queensland

This work presented in this thesis is to the best of my knowledge and belief original and my own work except as acknowledged in the text. The material contained in this thesis has not previously been submitted either in whole or in part, for a degree at this or any other university.

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_ Abstract>

Protected wilderness areas of environmental and natural importance, known as National Parks, attract people from all over the world to travel to Australia and enjoy the richness of a unique flora and fauna. Heron Island, a small sand coral cay at the southern end of the Great Barrier Reef, is such a site of major tourist interest. Although it is rigorously managed by the Queensland Parks and Wildlife Service to meet legislative requirements, large parts of the island have been modified to accommodate supportive structures for tourism and research activities most of which are environmentally inappropriate.

This thesis examines the architectural, social and environmental issues that need to be addressed in relation to building design on Heron Island. The aim is to create an appropriate architecture that minimizes the impact on both local eco-system and broader environment. The results of this research have been taken into account in the architectural design for new accommodation and laboratory facilities at the Heron Island Research Station. The project is based on the actual redevelopment planning by the Department of Property and Facilities Division of the University of Queensland.

Initially, a design brief was developed which explicitly included the objective of ensuring best practice in ecologically sustainable design (ESD). Secondly, the background research comprises a detailed site analysis which emphasizes three design issues that are analyzed in case studies. A hot humid climate, remote location and sensitive natural context characterize the fragile reef environment on Heron Island. Consequently, the objectives of this project were to:

- create thermal comfort through a climate responsive and resource saving design,
- respond to the lack of resources introducing renewable energies,

- provide flexible structures for easy transport, construction and maintenance,
- design buildings and their construction in such a way that biodiversity is conserved and prevent user impact through environmental education.

Based on these objectives a set of three strategies was developed which unify the design for accommodation and laboratory buildings in this thesis. Firstly, the architectural response for both structures suggested an elevated low-impact construction with minimum footprint, simplified through modular design and prefabrication. Secondly, the design focused on the human occupation of the building envelope and its interaction with the climate and the natural environment, therefore generating multiple social issues. And thirdly, environmental requirements were addressed in designing the buildings with the purpose of converting the research station into a largely self-sustaining facility in the future.

The project is presented through architectural drawings, diagrams and photographic illustrations and is concluded with a critical review by comparing brief and project outcome and testing the design by means of the Green Globe Certification checklist.

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_ Contents>

_ List of Figures>

_ List of Tables>

_Introduction>

In reflecting on recent sustainable architecture, I find that there are many unexploited opportunities. Having studied and practiced in Europe, I came to the realization that many architects do not have sufficient knowledge of sustainable design and that most of them remain unaware of environmental trends. Nevertheless, it is encouraging that there are a number of larger-scaled projects, such as office and public buildings, which incorporate environmental, mostly climate related design strategies. In the case of Queensland's architecture and particularly residential planning, there are remarkable examples of climate as well as site responsive design.

Due to the recession in the European construction business, I noticed how important it is for architects to concentrate on future oriented development, and I decided to pursue my interest in sustainable architecture by means of this study. Interestingly, the term 'sustainable' is hardly used in the German language, which uses the term 'ecological': both terms are too general. This thesis describes my personal attempt to reveal the meaning of sustainability in relation to architecture and to find a way to integrate and verify the results in the design of research facilities on Heron Island.

The term 'ecologically sustainable design' (ESD) was first used in the early 1990s when concerns about climate change entered architectural discourse. Referring to an early definition of sustainability by Brundtland in 1987, ESD expressed a new attitude to the world which ensures that any action meets the needs of the present without compromising the ability of future generations to meet their needs. [1] In *Understanding Sustainable Architecture* the authors suggest that

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[1] World Commission on Environment and Development (WCED), *Our Common Future* (The Brundtland Report) (Oxford: Oxford University Press, 1987), p.8:
'Humanity has the ability to make development sustainable – to ensure that it meets the needs of the present without comprimising the ability of future generations to meet their own needs... Sustainable development is not a fixed state of harmony, but rather a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are made consistent with future as well as present needs.'

the meaning of E varies between *environmental, ecological* and even *economic*, while D sometimes means *development* and sometimes *design*. While the S stands for *sustainable* (and *sustainability*), this term in recent usage has come to denote a broader perspective and a new way of looking at the world. [2]

Discoveries about the Greenhouse Effect were reason enough to encourage people from all over the world to participate in international conferences and to discuss global strategies to manage climate change. International agreements and environmental agendas, such as Agenda 21, resulted from these meetings and laid the theoretical foundation for many later publications, which demonstrated how sustainable design principles could be applied in architecture. An example of this was the RAIA Sustainable Design Guidelines (1995).

However, the roots of the 'green movement' reach back to the end of the last century when, in the context of a rapid industrialization, the Arts and Crafts movement demanded a return to nature. Also during the modern movement in the 1920s, ideas of sustainability such as shading and ventilation were constantly present in the work of Le Corbusier and the Bauhaus school. Frank Lloyd Wright at the same time sought to use local materials and traditional crafts in his attempt to create a modern architecture. [3] Wright's development of a regional building tradition was based on the fact that the sustainable approach has been developed and refined since the beginnings of human construction. By comparing the vernacular architecture of different geographical regions and climatic zones, we can see that traditional buildings demonstrate interaction with the given environment and a stable connection to the place.

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[2] Terry Williamson, Antony Radford, Helen Bennetts, *Understanding Sustainable Architecture* (London/ New York: Spon Press, 2003), p.3.
[3] Brian Edwards, Chrisna du Plessis, 'Snakes in Utopia- a Brief History of Sustainability', Architectural Design Vol. 71, *Green Architecture* (London: John Wiley & Sons Ltd, 2001), pp.9-13.
Colin Porteus, *The New Eco-architecture- alternatives from the modern movement* (London/NewYork: Spon Press, 2002), pp.IX-XI.

A familiar example is the German country house, which is constructed of a timber skeleton structure with fill panels called latticework. Characterized by a practical and pragmatic design that is founded on the availability of local materials and the nature of the local climate, these houses exist throughout the country. In the Black Forest the latticework house has to compete with the narrow and dark spaces of its surrounding countryside, which explains the powerful roof structure of these buildings with a pyramidal form of four long slopes. Houses in the hilly landscape of middle Germany are characterized by their decorative facades rather than the roof. The structural system is turned into a figurative assembly of reinforcements. The houses in Northern Germany, on the other hand, emphasize of a large pitch roof which contrasts with the enormous plains of the regional countryside. [4]

In distinction to the extrovert appearance of the central European building tradition, Hassan Fathy set an example for modern Egyptian architecture that is closely related to the local precedents of mud brick constructions and courtyard houses. His projects, especially the village designs for New Gourna and New Bariz, show not only an attempt to reinterpret traditional architecture and achieve natural environmental control by adapting the buildings to the challenge of climate and topography, but they also addressed the social problems that arose with the resettlement of hundreds of people. Fathy encouraged social sustainability as much in his architecture as he practiced it in his work: instead of making an architectural statement, he tried to contribute to a continuing process that is rooted in the traditions of the place. [5] Although Fathy described the approach as revitalizing, rather than reproducing the vernacular, his positive attitude towards derivation led to criticism of regionalism. [6]

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[4] Christian Norberg-Schulz, *Architecture: Presence, Language, Place* (Milan: Skira Editore, 2000), pp.240-246.
[5] James Steele, *Hassan Fathy- Architecural Monographs 13* (London: Academie Editions, 1988), p.25.
[6] Regionalism in the discussion of critical regionalism opposed to popular regionalism: Kenneth Frampton, *Towards a Critical Regionalism*, p.21.
see also the distinction between Romantic Regionalism and Critical Regionalism in Alexander Tzonis, Liane Lefaivre, Critical Regionalism in *Critical Regionalism: The Pomona Meeting Proceedings*, ed. Spyros Amourgis (Pomona: California State Polytechnic University, 1991), pp.3-23.

Similar charges occurred in recent discussions on Queensland's contemporary architecture in relation to vernacular examples of farm sheds and verandah houses. The traditional Queenslander House is basically a square box which is erected above the ground on stumps to respond to the heat and humidity of the sub-topical climate, insect plagues and flood dangers. The basic materials for its construction are timber for both the structure and the cladding and galvanized corrugated-iron sheeting for the pitched roof. Enormous verandahs with decorative timber or iron trimmings surround Queenslander Houses and, being protected by large roof overhangs and screens, these extensions offer interesting spatial arrangements between the inside and outside. The wall cladding of houses in tropical Northern Queensland was even reduced to a permeable enclosure of timber screens and, apart from central services, all living and bed rooms, also called sleep-outs, were located along the ventilated facade. Recent residential architecture in Queensland incorporates characteristics of these light pavilions and their ambiguous space qualities, implying familiar elements like timber batten screens and louvre windows. Forward looking designs, especially those located in remote areas, demonstrate how these elements can be complemented with modern high-tech installations, such as photovoltaic panels and rainwater collection systems.

In conclusion, these examples of vernacular and traditionally rooted architecture demonstrate the necessity for a universal design approach. The book *Understanding Sustainable Architecture*, identifies three principal images of architectural sustainability: the natural image, the cultural image and the technical image. [7] In architectural practice these 'images' are mostly used in combination and each of the above examples shows them to varying degrees. The natural image means 'to work *with*, not *against*, nature; to

[7] Terry Williamson, Antony Radford, Helen Bennetts, *Understanding Sustainable Architecture* (London/New York: Spon Press, 2003), p.25.
'By 'images' in this book we mean both the visual image (the most common meaning of the world) and what occurs '*behind* the eye', the way we represent ideas to ourselves and to others and the impressions we have of other people, products and things.' p.21.

understand, sensitively exploit and simultaneously avoid damaging natural systems'. This issue is well illustrated in all three examples, as each one of them is designed in close relationship to its environmental context. The cultural image, on the other hand, which is concerned with the protection and continuation of a *genius loci*, as well as the relationship between a social community and its built environment, finds best expression in Fathy's approach. Reinforced by natural and technical aspects, his architecture not only emphasizes the cultural background, but it also addresses local people's needs. The technical image, finally, embraces the possibilities of contemporary technologies. This aspect occurrs in the latticework construction of the German vernacular, as well as in the design of lightweight and self-sufficient Queenslander houses from the last century to the present day. [8]

This thesis and the accompanying project have both been produced in this context. Following the aim to find an appropriate design solution which responds ideally to all three images, this thesis proposes the use of ESD principles in order to achieve an architecture that incorporates the spirit of the place.

The study on Heron Island was selected, because the cay is part of a tourist magnet, the Great Barrier Reef, as well as being part of my experience as a visitor in Queensland. The island is shared by a resort and a research station which indicates that one significant task in this project is to address social sustainability. My visit to the island reinforced this impression, when I was introduced to the educational program of the Queensland National Parks and Wildlife Service on my way to the island. The authorities have set up a very effective information system which aims to control tourist actions in order to keep their influence on the local ecosystem as low as possible. In view of the increasing international importance of the Heron Island Research Station, a principal idea of this thesis is to

[8] Terry Williamson, Antony Radford, Helen Bennetts, *Understanding Sustainable Architecture* (London/New York: Spon Press, 2003), pp.27-32.

develop new facilities in such a way that the architectural statement underlines and cooperates with the instructive program of the National Park authorities.

The existing structures on Heron Island clearly demonstrate which problems need to be addressed in the design of new facilities. The most inappropriate buildings on the island are part of the P&O Resort: massive two-storey houses, fully air-conditioned, are located directly on the Northern beach. Compared to this exposure, the research station is carefully hidden behind the tree line of the Southern beach. [9] Built of light timber constructions, the original buildings from the 1950s are still in use, even though they are situated directly on the ground and spartan air-conditioning systems characterize their outer appearance. Newly elevated buildings, constructed in a first development stage in 2002, have made an important contribution to reducing the environmental impact of the station and also offer valuable design lessons for my project. Energy efficiency and the conservation of biodiversity have been addressed by applying passive design strategies and by minimizing the building footprints respectively. The first stage design presents an acceptable environmental response, whereas the social and technical value of the buildings is still questionable. Treated like separate objects, the new facilities lack integration into the larger context and do not take advantage of contemporary, resource saving technologies, such as solar energy and water-based air-conditioning. [10]

In order to achieve a more sophisticated design solution, this thesis analyzes the strategies of six different projects with comparable environmental contexts and similar briefs. All these buildings have been consciously designed on ESD principles. I selected two projects for each of the following three categories: remote building, the sensitive natural environment and the hot humid climate. Firstly, the remote projects demonstrate common design

[9] Please see for more information part 1_2_2 Heron Island's community
[10] Please see for more information part 2_1_3 Current infrastructure

strategies to achieve a simple construction and to render the building self-sufficient. [11] Secondly, the examples built in National Parks show different ways to actively protect the environment through building design and its educative effect on the user. [12] Finally, the two contrasting responses to the sub-/tropical climate display how active and passive climate control can be used and combined in an intelligent building design. [13] These case studies are largely based on available publications as my short stay in Australia allowed me to visit only two of the six projects: the Kingfisher Bay Resort on Fraser Island and the Sunshine Coast University Library.

This thesis describes a long process in which the term 'sustainable architecture' is finally decoded as simply an 'architecture of responsiveness'. [14] ESD strategies are used to develop a built form and a spatial organization which establishes a close relationship with the particular site. The spirit of the place is informed and augmented by the application of ESD principles. This strategy is not limited to a certain place, but can and should be applied with modifications in other parts of the world.

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[11] Please see for more information part 2_2_1 Remote Location
[12] Please see for more information part 2_2_2 Sensitive Environment
[13] Please see for more information part 2_2_3 Hot Humid Climate
[14] Quote by Richard Rogers in Brian Edwards, Chrisna du Plessis, 'Snakes in Utopia- a Brief History of Sustainability', Architectural Design Vol. 71, *Green Architecture* (London: John Wiley & Sons Ltd, 2001), p.18.

Part 1_ Brief>

1_1 Objectives

The key objectives for the redevelopment of the Heron Island Research Station are to:

> provide appropriate site planning and building design for the sensitive environment of Heron Island which responds to architectural, social and environmental requirements,

> ensure best practice in ecologically sustainable design (ESD)

> investigate educational aspects of sustainability through the design of an interpretive facility that promotes responsible use and enhances public understanding, appreciation and enjoyment of the cay environment.

1_2 Background

1_2_1 Management

Fig.1 Aerial View of Heron Island and the Reef

Heron Island is a true sand coral cay on one of the 22 reefs forming the Capricorn-Bunker Group at the southern end of the Great Barrier Reef. The 19 ha island, approximately 800m long and 300m wide at its maximum, is located about 70km offshore from Gladstone, on the central coast of Queensland. Its maximum height above the mean high water level is 5.6m. A total area of 13.5 ha of the cay is vegetated, dominated by a forest of *Pisonia Grandis* which provides nesting habitat for thousands of migrant and resident birds. The two dominant bird species on Heron Island are the Wedge-tailed Shearwaters and the Black Noddies. Moreover, the island is one of the few concentrated sea turtle nesting areas in

Queensland. It is home to a large number of fish and coral species found in the Great Barrier Reef.

Heron Island is part of the Great Barrier Reef Marine Park and is therefore subject to severe regulations set up in the *Nature Conservation Act 1992* and in the *Capricornia Cays National Park Management Plan*:

The major purposes of management will be to ensure that:

> biological diversity within plant and animal communities is conserved and natural ecological processes continue with minimum disturbance;
> sensitive habitats and rare and threatened species are conserved through appropriate management strategies;
> landscape values are retained at their present high levels;
> cultural resources and items of heritage significance are adequately conserved, and where appropriate, are interpreted;
> opportunities for ecologically sustainable and nature-based activities are provided, and where possible should complement activities in surrounding marine parks; and
> opportunities for appropriate scientific research are provided to help identify park resources and improve park management.[1]

The objectives of this management plan have to be considered for future development at the research station. It must be remembered that the island is a fragile ecosystem and that building interventions endanger its sensitive balance. The delicate nature of this unique plant and animal life must be considered and respected.

[1] The State of Queensland, Queensland Parks and Wildlife Service, Capricornia Cays National Park Management Plan, 2000, p.8

1_2_2 Community


Fig.2 Aerial View of Heron Island

The community on the island is formed by three stakeholders: the P&O Resort with an area of 4.6ha, the Heron Island Research Station and the QNPSW Base, the latter two of which are both located within the 14.4ha National Park. The University of Queensland leases the 2ha site of the research station from the Queensland Parks and Wildlife Service.

The island is divided in two parts: the National Park area with its original forest in the east and the built area with the resort and research station structures in the west. The built area itself has been organized in a way that the research facility in the southern part is separated from the tourist structures in the northern part. The resort service area located between the two zones functions like a filter.

The resort was the first facility that was established on Heron Island in 1932. It was created from the remains of a turtle soup cannery that operated from 1925 to 1929. In the late 1970s the resort was bought by P&O Resort Ltd. The QNPSW base accommodates two rangers, based on the island to manage the National Park. The research station was established by the Great Barrier Reef Committee in 1951 and was one of the first research facilities of its kind in the world. In 1970, the University of Queensland took over the operation of the station and manages it to this day. Already in 1943 Heron Island was declared a National Park. Approximately 20.000 visitors come to Heron Island every year; most of them are resort guests.

Cooperation between the research station and the resort is fundamental to sharing the island in a profitable way for both. The resort provides the electricity and water supply for the entire island. It also operates the island sewage treatment plant. Occupants of the research station have limited access to the resort facilities. There is a Marine Parks Information Centre located in the resort. Management staff of either the research station or the resort give introductory talks to educational groups and resort guests and organize guided tours to Heron Island's natural attractions and the research station's aquariums. The active exchange between both facilities needs to be extended and new initiatives created to promote a *sustainable community*. Guidelines developed by the Heron Island Management Committee (HIMC), which is composed of representatives from the P&O Resort, the Heron Island Research Station and the Queensland Parks and Wildlife Service, provide coordinated site management and control of activities on Heron Island.[2]

1_2_3 Development Plan

In order to upgrade the research station and to provide research facilities of an international standard, the UQ Department of Property and Facilities Division set up the Heron Island Research Station Site Development Plan. Cost estimates led to the decision to re-build several of the buildings that had been erected when the research station was established in the 1950s. Previous planning had continually expanded the research station eastward and westward, but this plan provides small scale changes that keep the impact of human activity to a minimum and incorporate sustainable development principles.

The research station is divided into three zones: a support service zone in the west, an operational zone in the middle and an accommodation zone in the east. A circulation path from west to east connects these zones and the major activities. The island is accessible on foot and vehicular access is permitted only for transporting boats and machinery. Visitors enter the station from the beach

[2] Heron Island Management Committee, Master Plan, Heron Island Management Guidelines (HIMG), November 1998

entrance path that leads them to a public area which connects service and operational zone.

The service zone has a reception and office building, a laundry facility and a boatshed with workshop, scuba diving facility and several small service sheds. The operational zone comprises a teaching facility, a seminar building, a laboratory building that needs to be renewed, a kitchen and dining facility, an ablutions block and several aquariums and tanks. Self-contained cabins and dormitories for approximately 50 researchers and full-time staff are located in the accommodation zone. New student accommodation will replace a group of five obsolete cabins next to the ablutions block.

The research station accommodates and caters for up to 100 students and scientists. The station management does not intend to increase the number of visitors to minimize the environmental impact. The overall character of the 30 existing buildings is composed of varying sized, simple timber buildings of 1 and 2 storeys surrounded by a dense natural vegetation.

According to the Heron Island Development Plan, the research station will be upgraded in three stages: the first stage included the teaching facility and the dining facility in the operational zone. Planning and construction for both facilities were finished in 2002. The second stage comprises the planning for the new student accommodation and the laboratory building. In the third stage, new researcher accommodation will be built.[3] >Fig.3

[3] Department of Property and Facilities Division, The University of Queensland, Heron Island Site Development Plan 2002, July 2002

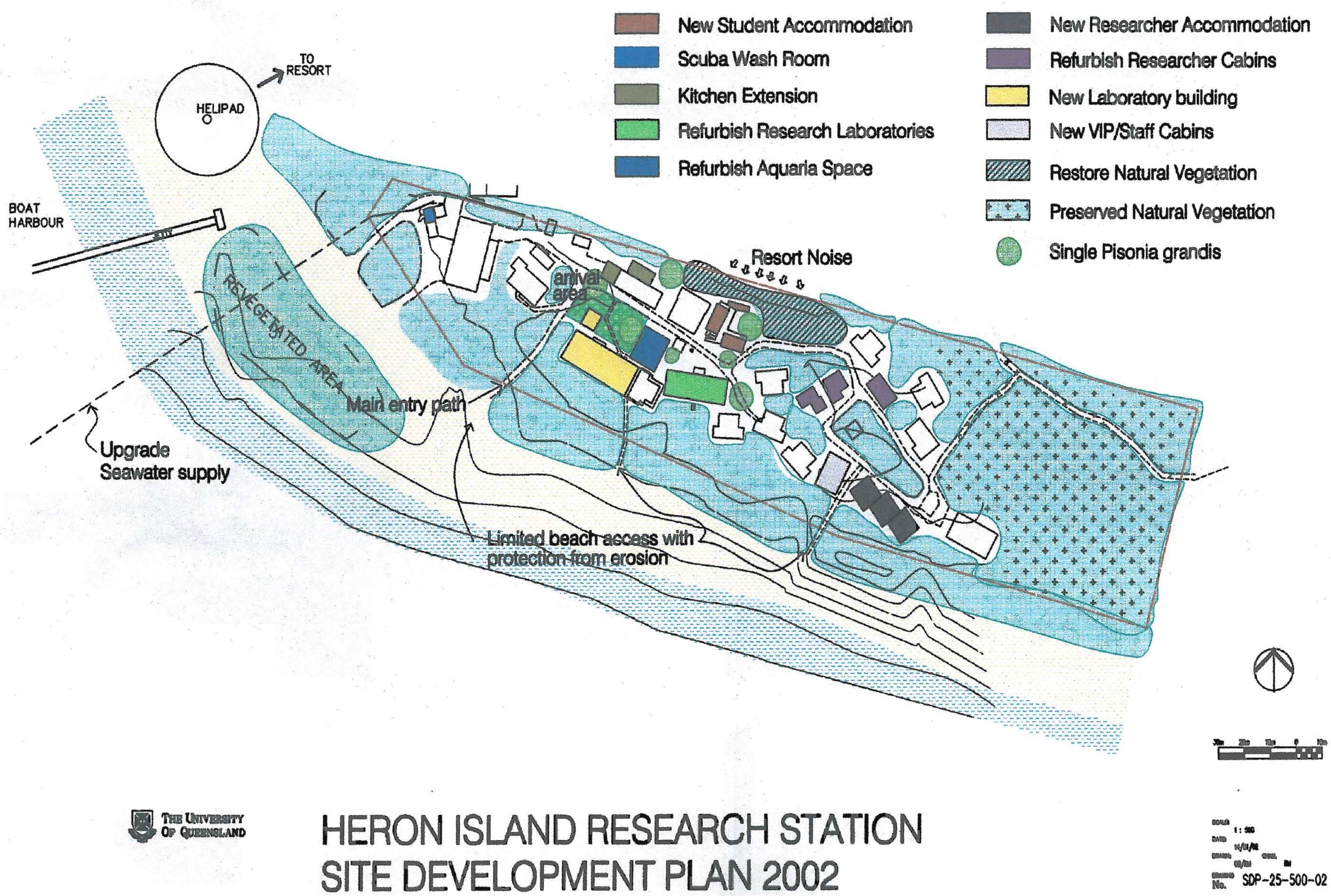

Fig.3 Heron Island Research Station Site Development Plan

1_2_4 Climate

Heron Island, situated at -23° latitude and 152° longitude, lies on the Tropic of Capricorn which locates it well within the hot humid climate zone. This indicates that temperatures are relatively high throughout the year and are generally accompanied by high humidity levels. From June to August, the average temperature levels are well below the comfort zone; for the other month the levels are mostly higher.

The average annual rainfall for Heron Island is about 1000mm, most of it occurring in the summer months as intensive tropical storms. Heron Island is subject to regularly occurring cyclones which generally move across the island in a south-westerly direction. Southeast winds blow at an average of 20km/h for approximately 70% of the year.[4]

With these climatic conditions, the priorities in design are to exclude sun penetration and to minimize solar radiation for most of the year, while optimizing natural ventilation and capturing cooling breezes from the sea.

1_2_5 Flora and Fauna

Heron Island is characterized by a dense *Pisonia Grandis* forest with a canopy coverage of 5-90%. In the western part of the island, the existence of Pisonia trees has been drastically diminished in order to establish the structures for the resort and the research station. Some areas have already been re-vegetated with indigenous plants. The Heron Island Management Committee (HIMC) set up a policy that

[4] Please see for more information on Heron Island's climate part 2, 2_1_1

restricts building heights below the vegetation canopy when viewed from the beach.

Pisonia trees offer habitat to a wide range of birds, especially the Black Noddies, which collect the Pisonia leaves to build their nests on their branches. Another dominant bird population on Heron Island is the Wedge-tailed Shearwater, also called the Mutton Bird, which returns each year to the same burrow. Mutton birds nests on the ground. Therefore, the HIMC set up another policy which made it compulsory to raise the buildings of any future development above the ground. The construction on posts also provides an appropriate solution to prevent root damaging.

Heron Island is the home of some endangered turtle species. Turtles come to the island to lay their eggs during the summer months. They move up the beach from one hour before night high tide to two hours afterwards and any disturbance, especially exposed lighting, can hinder the breeding process disorienting both turtles and hatchlings. In this case the HIMC policy prescribes that none of the buildings within the research station should be visible from the beach. A distance of 30m from the high water mark has to be kept and replacement buildings must not be farther seaward than existing buildings.

Construction works on Heron Island have to be programmed according to the following limitations: due to tree nesting species, vegetation clearing and site preparation have to be done between 30th April and 1st October; ground nesting species limit footing or ground works during the period 21st May to 30th September; and because of the turtle nesting, no construction can be carried out between 30th April and 1st October.[5] [6]

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[5] Heron Island Management Committee, Master Plan, Heron Island Management Guidelines (HIMG), November 1998

[6] Please see for more information on Heron Island's flora and fauna in part 2, 2_1_2

1_3 Design Criteria

1_3_1 Agenda 21 Assessment

The target of this project is to design buildings that are appropriate to their location in the fragile eco-system of Heron Island. The Green Globe Certification design issues, based on the Agenda 21 principles that have been developed from international policy generated from the Kyoto Protocol and other world forms on sustainability, offer useful guidelines to fulfill this target. The following summarizes these principles:

Siting Issues

> Building footprint and the building-site interface should be minimized. Disturbance of the site topography and water substructure through foundations need to be avoided and biodiversity protected.

> The design has to be verified with regard to its solar orientation and thermal performance.

Energy Efficiency and Conservation

> Passive design strategies, which require the use of natural materials and energy flows available to the site and through the building form and fabric to provide thermal comfort for the occupants, should be applied. Strategy examples are:

_ Cooling through cross ventilation
_ Sun Shading through verandahs and trees
_ Energy Efficiency through building form and fabric, e.g. high level of insulation
_ Natural Day Lighting

> Active design strategies need to be avoided but might be required in some circumstances to create climatically controlled space. In this case, advanced air conditioning techniques for cooling and heating need to be supported by intelligent building design.

Selection of Building Materials and Process

> Embodied energy, transportation energy, recycling possibilities, toxic ingredients, low maintenance strategy and resistance to climatic conditions need to be considered when selecting the material.

> The assembly process can be facilitated through prefabrication causing less construction waste and using local labour and skills.

Protection of Air, Earth and Water

> Conservation, collection and recycling of resources need to be maximized by applying the following strategies:

_ Installation of a tertiary sewage treatment plant that is designed to have zero impact on the waters of the Great Barrier Reef and permits the reuse of grey water, e.g. for toilets

_ Use of rainwater collection roofs and tanks

_ Separation of waste and on-site recycling

> Alternative energy sources such as solar thermal and solar electric systems and wind generators need to be considered to replace the existing diesel powered generator.

Construction

> The design has to be verified with regard to waste, water, construction and transport energy consumption.

The Green Globe Certification comprises another important point:

Social issues need to be confronted in order to contribute to sustainable development. Design and Planning should enhance social and cultural interaction.[7]

Heron Island's natural environment is protected by law and permitted activities on the island are considered to be sustainable. Inhabitants and especially visitors need to be informed to understand the environmental issues and develop sensitivity for the place. New structures for these people could have the potential to create greater awareness of the natural environment. Architectural design should be used as an instrument for *environmental education*. It might influence and improve people's behaviour on the island and subsequently.

[7] Richard Hyde, Joyce Law, Sarah Bridges, The Centre of Sustainable Design, The University of Queensland, Green Globe Facilities & Infrastructure Design Certification, Benchmarking Report for the Heron Island Research Station Redevelopment: Dining Facility and Teaching Facility, 2003

1_4 Design Data

This project is concerned with the requirements of the second stage of the Heron Island Research Station Development Plan regarding the construction of new student accommodation and a modern laboratory building, both located on the edge between the operational and the accommodation zone.

1_4_1 Site

The site provided for the accommodation is limited by the path, the ablutions block, the boundary with the resort and the footprint of the cabins that are going to be demolished. Parts of the area are characterized by dense vegetation where Mutton birds occupy the ground. A large Pisonia tree in the centre of the site and several medium trees located all over the site need to be considered. Due to noise from the resort staff club, the new accommodation may be moved away from the boundary.

The existing laboratory building is located on the opposite side of the path. The site is defined by the aquarium shed, the edge of the seminar building, the dense vegetation towards the beach and towards the staff accommodation. Several large trees need to be maintained, especially an old Pisonia tree which is located next to the aquarium in front of the old laboratory. Mutton bird nests cover the ground between the existing laboratory building and the vegetation towards the beach. The area in front of the existing laboratory building is sparely covered with grass and used to store movable tanks.

The complete site for both buildings is approximately 3 to 3.5 m above the high water line and rises gently towards the boundary with the resort. The sandy soil of the island needs to be considered in the foundation planning.

1_4_2 Program

Accommodation Facility

The accommodation facility will replace five simple cabins that are located near the resort staff accommodation. These cabins are regularly used throughout the year and offer dormitory space for at most 50 school or undergraduate students in bunk beds. The new dormitory building will provide accommodation for 64 students. This needs to be situated close to the existing ablutions block which contains all service facilities. A separate section accommodating 6 teachers or tutors will be equipped with separate amenities.

For the program please see Tab.1.

The new accommodation should be designed so that the old Pisonia trees do not need to be cut down. The protection of the dense site vegetation as well as the bird-population is an important issue for this project. The building should be designed in a way that the birds are minimally disturbed in their nesting and hatching habits. Night lighting in- and outside the building needs to be kept at a low level to avoid distracting the turtles.

Fig.4 Site for Accommodation

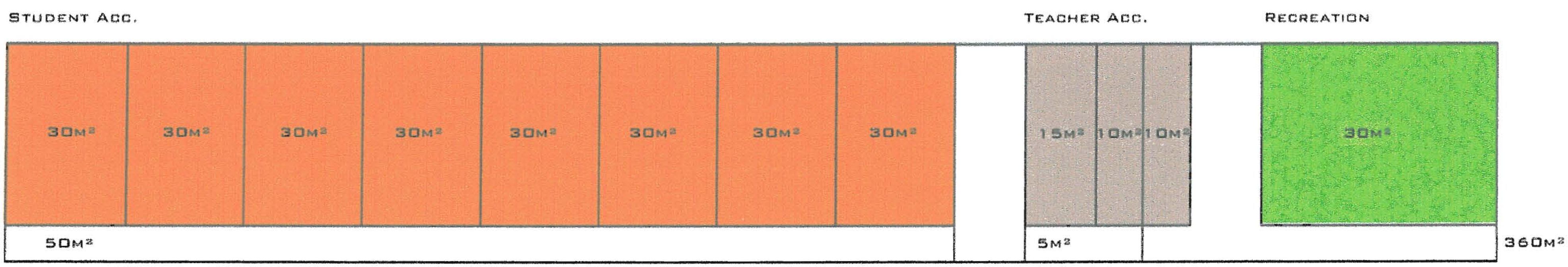

Fig.5 Program Accommodation

Tab. 1	floor area	ceiling height	accommodation	environment	relationship to other areas	furniture/ equipment	indoor finishes	outdoor finishes	services
dormitory 1	30m²	min.2.5m	8 students	thermal insulation, natural + mechanical ventilation (user+sensor manipulated)	relationship with outdoors	8 beds, shelves/ waredrobes	timber	timber, sliding windows with moscito net + stormshutter	electric power/ light
dormitory 2	30m²	"	"	"	"	"	"	"	"
dormitory 3	30m²	"	"	"	"	"	"	"	"
dormitory 4	30m²	"	"	"	"	"	"	"	"
dormitory 5	30m²	"	"	"	"	"	"	"	"
dormitory 6	30m²	"	"	"	"	"	"	"	"
dormitory 7	30m²	"	"	"	"	"	"	"	"
dormitory 8	30m²	"	"	"	"	"	"	"	"
circulation (20%of total area)	50m²			night lighting, partly covered				timber flooring	electric power/ light
total student acc	290m²		64 students						
cabin 1	15m²	min.2.5m	4 teachers/tutors	thermal insulation, natural + mechanical ventilation (user+sensor manipulated)	reasonable distance to dormitories	4 beds, shelves/ waredrobes	timber	timber, sliding windows with moscito net + stormshutter	electric power/ light
cabin 2	10m²	"	2 teachers/tutors	disabled access	"	2 beds, shelves/ waredrobes	"	"	"
teacher amenities	10m²	"		disabled access		sanitary euipment for disabled people	"	timber	electric power/ light, c/h water + drainage
circulation (20%of total area)	5m²			night lighting, partly covered				timber flooring	electric power/ light
total teacher acc	40m²		6 teachers/ tutors						
outdoor recreation	30m²			shaded platforms, night lighting, partly covered	central to dormitories, embedded in vegetation	seating		timber flooring	electric power/ light
total	360m²								

Laboratory Facilities

The new laboratory building will replace the existing Roche building which is located next to the seminar building and the aquarium shed. The Roche building is a two-storey building with three laboratory units and an instrument room on the ground floor. On the first level there is an office, a computer room, a library with provisional office space and a student retreat room. The laboratory equipment store is temporarily located on the ground floor of the two-storey seminar building. The upper level of the seminar building provides a new teaching lab which is not used as a result of technical problems.

The wet laboratory, aquarium, tanks and a walk-in cold room are located under a central aquarium shed. Different lighting levels, varying from total darkness to exposed sunshine, are needed for aquariums and tanks. A lot of work is done outdoors, under the shed and the verandah in front of the laboratories.

For the program please see Tab.2.

The laboratory project comprises a reorganization of the operational zone including the aquarium area, the seminar building and the laboratory. The purpose of the seminar building needs to be reconsidered. There is a cleared void between the seminar building and the new teaching facility that should be taken into consideration for this development.

The design for the laboratory facilities needs to take into account a tall Pisonia tree next to the high salt water tank. The dense vegetation towards the beach is extremely important to screen the lighting from the laboratories. Night lighting should be reduced to a minimum.

A standard laboratory with high flexibility is needed to facilitate a range of research purposes (biological, environmental, geographical studies) and accommodate changing numbers of international users for different lengths of time. The variety of in- and outdoor working spaces should be maintained in the design of the new facility. A clear organization of the operational zone into research and teaching areas is important to create a professional research environment. To receive visitor groups from the resort, the design should include a safe and representative demonstration area.

Attention needs to be paid to provide sufficient day lighting in the building, excluding the direct sun light. Laboratories have to be environments with stable conditions. Therefore, the building should be designed to include air-conditioning as well as natural ventilation.

Fig.6 Site for Laboratory Facilities

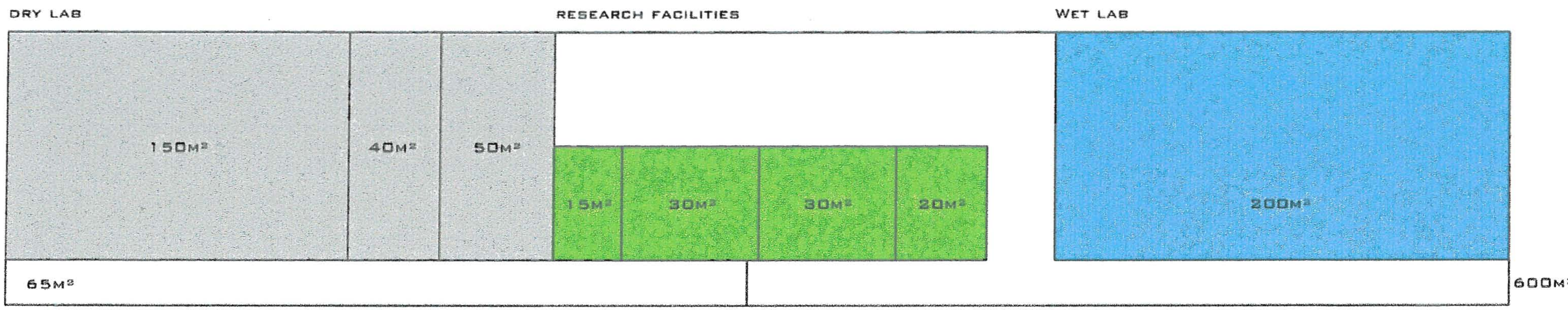

Fig.7 Program Laboratory Facilities

Tab.2	floor area	ceiling height	accommodation	environment	relationship to other areas	furniture/ equipment	indoor finishes	outdoor finishes	services	special equipment
dry lab(open space)	150m²	min.2.7m	15-20 researchers (+research assistents)	daylighting, user+sensor manipulated lighting, air conditioning/ natural ventilation switch system with control system, thermal insulation	access to wet lab and aquarium, limited 24h access	movable island benches/ write-up (2x1.5m/person, adjustable height), over-bench shelves, technical equipment	timber, linoleum, chemical resistant surfaces, round edges	timber, glass curtain/ sliding windows/ louvres with shading devices	electric power/ light, c/h water + drainage, salt water + drainage, communication	1x safety station: emergency shower and eyewash
instrument lab	30m²	min.2.7m		"	central to both labs, limited 24h access	benches for commonly used technical equipment (>0.75m), stable benches, waste containers, storage	"	"	"	2x fume cupboards 1.5x0.8x2.8m 1x -70degree freezer 2.0x1.0x1.0m 2x glass door fridges 0.8x1.0x2.0m 1x autoclave 0.8x1.0x1.5m 1x calorimeter (not floor st.) 0.8x0.8x0.6m 2x centrifuges (not floor st.) max.1.0x1.2x0.6m 1x centrifuge 0.8x0.8x1.0m 1x freeze drier 0.8x0.8x1.2m 1x incubator shaker (not floor st.) 0.8x0.8x0.6m 1x -50degree incubator 0.8x0.8x1.5m 1x microwave (not floor st.) 0.8x0.8x0.5m 2x ovens 1.0x1.5x1.2m/ 0.8x0.8x1.0m 3x spectrophotometers (not floor st.) max.1.0x1.0x0.5m 1x destilled water system (on wall) 2.0x0.8x2.0m 1x dishwasher 0.8x0.8x1.0m 4x microfuges (not floor st.,small instruments) 4x microscopes (on 0.8x1.0m stable bench) 1x balance (on 0.8x1.0m stable bench) 3x regulators, oxygen/ nitrogen (on wall) 3x vacuum pumps (on wall)
walk-in **cold room**	10m²	2.5m		total temperature control, dark room		1 person bench space, shelving	prefabricated cell	prefabricated cell	electric power/ light	
equipment store	50m²	min.2.5m		air conditioning/natural ventilation, thermal insulation	vicinity to labs and office, limited 24h access	equipment in standard cupboards, glass store, computer station	timber, linoleum, chemical resistant surfaces, round edges	timber, sliding windows with shading devices	electric power/ light, communication	flammable liquids are stored in a chemical store in the service area
lab manager office	15m²	min.2.5m	2 staff	daylighting, air conditioning/ natural ventilation, thermal insulation	vicinity to labs and store, limited access	2 workstations, storage for special equipment (cameras)	timber, linoleum	timber, sliding windows with shading devices	electric power/ light, communication	
library	30m²	min.2.7m		"	limited access	bookshelves, desks, seats, computer station	"	"	electric power/ light, communication	

researcher study	30m^2	min.2.5m		"	limited access	10 computer workstations, printer, scanner, photocopier, desks, seats	"	"	electric power/ light, communication	
student study	20m^2	min.2.5m		"	limited access	6 computer workstations, printer, desks, seats	"	"	electric power/ light, communication	
circulation (20% of total area)	65m^2			reduced night lighting, covered	in/ outdoors			timber flooring	electric power/ light	
total (in)	**400m^2**									
wet lab(open space) **and aquarium**	200m^2	min.2.5m		partly covered, closing devices, natural ventilation, reduced night lighting	in-/outdoor, limited access for visitors	covered aquarium 5.0x5.0m, different sized tanks+structure, fixed and movable benches, movable under bench store elements, equipment		easily cleanable surfaces, removable enclosure elements, timber flooring	electric power/ light, c/h water + drainage, salt water + drainage, communication	6x tanks 1.0x0.5x0.5m 4x round tanks d=1.7m, h=1.1m, 4x timber structures 2.0x1.0x2.0m with 8x flat tanks 1.8x0.9x0.2m 8x timber structures 2.0x1.0x1.0m with 16x aquariums 0.7x0.4x0.5m 1x aquarium 2.5x0.5x0.5m 1x flat tank 1.8x0.9x0.2m 6x timber structures 2.0x1.0x2.0m with 45x aquariums 0.7x0.4x0.5m 3x steel structures 2.0x1.0x2.0m with 20x aquariums 0.7x0.4x0.5m
total	**600m^2**									

1_4_3 Services

A central supply channel under the main path feeds the research station facilities with power, water and communication. The research station depends on the supply systems of the nearby P&O Resort which provides a desalination system, diesel generators and sewage treatment plant.

Electricity is supplied through a 240V underground distribution from two diesel powered generators. Future developments should replace these with systems that generate electricity from sun or wind energy. At the moment, solar power is only used to heat the water for staff cabins and the ablutions block.

The resort desalination unit supplies the research station with fresh water. The daily supply limit is 11000l, and the daily consumption varies from 6000 to 7000l. Filtered grey water is used for toilets and outdoor taps. It is provided by the resort tertiary sewage treatment plant that takes in a maximum waste water delivery of $18m^3$ per day from the research station. There is an existing underground rainwater tank with a 130000l capacity. Rainwater collection strategies should be extended. The aquariums and tanks have a seawater circulation system with an intake near the harbour channel and an outlet at the beach in front of the research station.[8]

[8] Please see for more information on services at the HIRS part 2, 2_1_3

Part 2_ Background Research>

2_1 Site Analysis

2_1_1 Climate

Heron Island lies on the Tropic of Capricorn and is therefore situated right between the subtropical and tropical climate zone. Hot humid conditions with an average daily temperature range from 21°C to 26°C are close to the comfort zone (22-27°C) throughout the year. The average summer maximum temperature is 30°C and the average winter minimum is 16°C. Only in the winter months do temperatures fall below the comfort zone. High temperatures during the rest of the year are combined with high humidity levels. The average relative humidity of 70% lies above thermal comfort. >Fig.8

The CPZ analysis for Heron Island demonstrates how the environmental variables which influence people's sense of thermal comfort can be enhanced by design. The psychrometric chart shows that the monthly lines are grouped on top of the comfort zone and most of them even outside it. To increase the correspondence of lines and the comfort zone, the zone can be extended through different climatic design strategies. In this case, a comparison of the four charts shows that the ventilation effect is the most appropriate strategy for establishing comfort during periods of extreme heat and humidity. Solar gain increases thermal comfort during cooler periods. The requirements of heating have to be considered carefully, because the charts are based on the comfort measurements for lightly clothed people. Mass effect and evaporative cooling are not applicable. >Fig.11

Wind conditions on Heron Island are favourable for ventilation. The prevailing winds are from the southeast, averaging a wind speed of 21km/h throughout the year. However, the effect of either breezes or storms is reduced by the existing vegetation and the fact that the site is slightly lower than the surrounding terrain. Cyclones occur almost regularly in the Capricorn Region and affect the island from a north-eastern direction during the summer months. Buildings have to comply with the region's specific cyclone codes. Storm shutters and roof overhangs should be provided, especially on northern elevations, to protect the buildings against cyclonic storms and accompanying extreme rainfall. >Fig.9

Clear sky conditions cause high levels of irradiation, particularly in summer. Buildings need to be protected against overheating. The temperature plot shows the overheated period from October to April. Full shading is to be provided for these months. Controlled sun penetration is desirable from June to August. The sun path diagram shows that the window design needs to take into account a minimum altitude of 47° in June and a maximum altitude of 88° in December. As the sun nearly reaches its zenith in summer, solar panels can be installed almost horizontally. >Fig.10

The average annual rainfall is 1059mm which occurs over 130 annual rain days. Most rain falls in the wet season between December and June. This fact needs to be considered in the design of roof, drainage and rainwater collection systems, which require tanks that can store water throughout the seasons with less rainfall.[1] >Fig.8

[1] http://www.bom.gov.au/climate/averages/tables/cw_039122.shtml, 26.07.2003

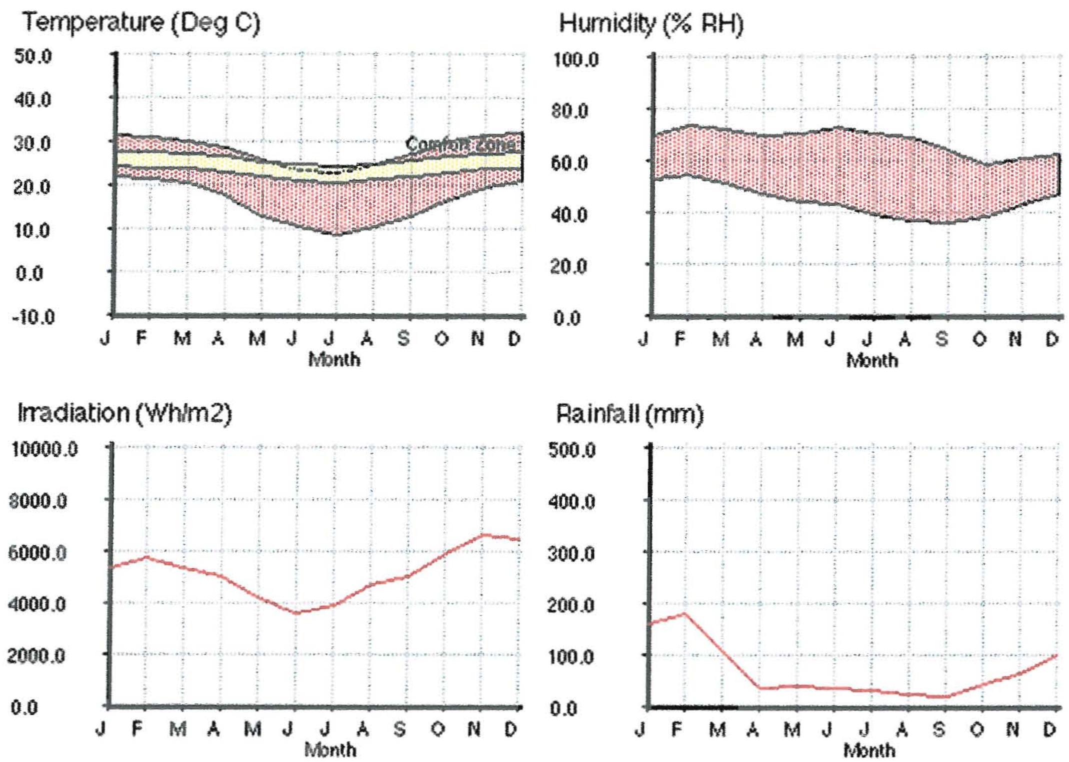

Fig.8 Climatic Graphs for Rockhampton

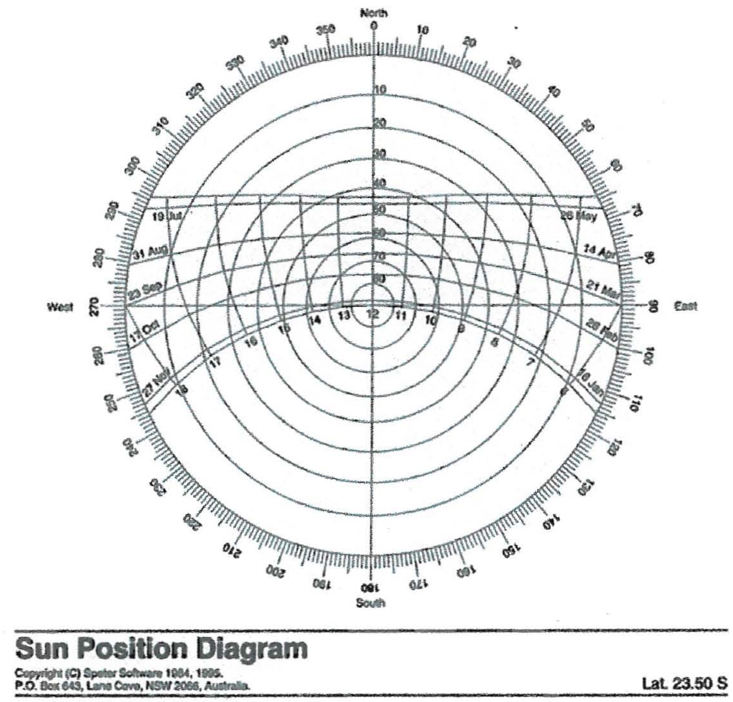

Fig.10 Sunpath Diagram Heron Island

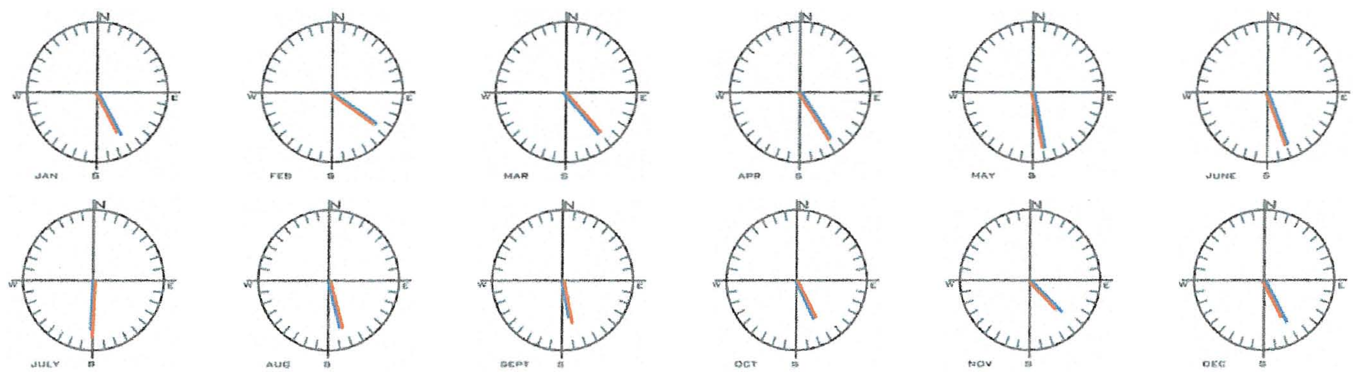

Fig.9 Wind Graphs Heron Island

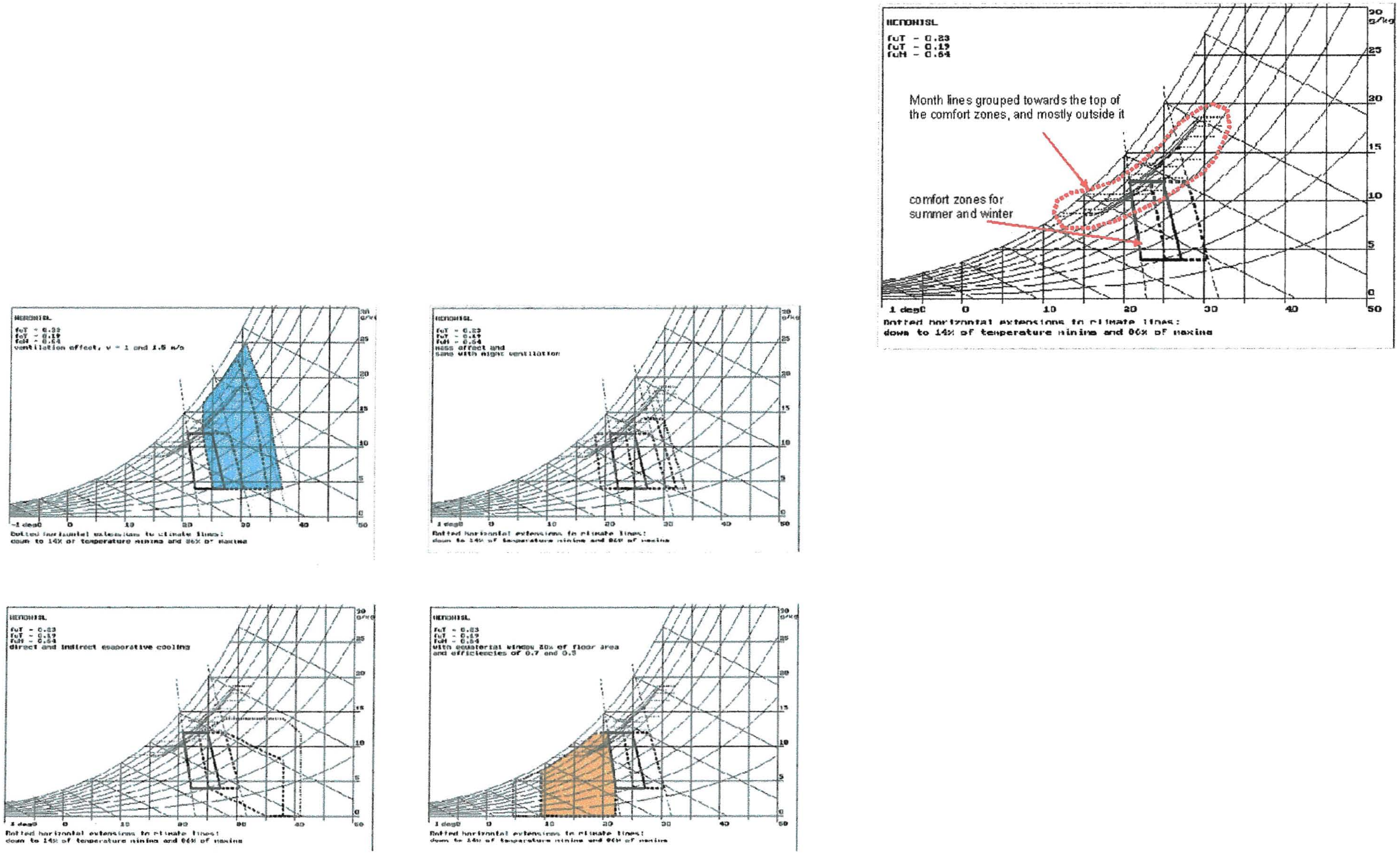

Fig.11 Psychrometric Charts for Heron Island

2_1_2 Vegetation and Wildlife

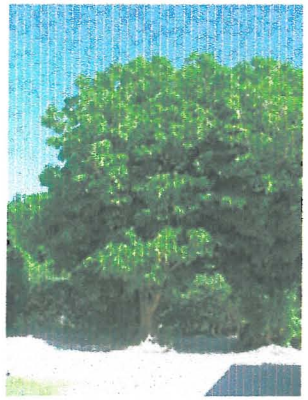

Fig.12 Pisonia Tree

The site of the Heron Island Research Station is at the island's southern beachfront. Separated from the beach by a dense line of native vegetation, the buildings have been established in a light hollow at about 3.0 to 3.5m above the high water line. The terrain rises gently towards the resort's northern boundary.

Originally covered by a dense forest of *Pisonia Grandis, Ficus opposita, Pipturus argenteus* and *Celtis paniculata*, large parts of the site have been cleared to provide paths and buildings. While the western accommodation zone is still characterized by parts of dense forest, the eastern operation and service zones are largely disturbed areas with only a couple of trees remaining. There are some tall Pisonia trees lright next to the ablutions block and around the existing Roche laboratory at the edge of the operational zone and towards the beach. Single Pisonia trees with more than an 80cm trunk diameter are located on both sides of the existing aquarium shed. Being part of the National Park, the vegetation on the site must be protected. Rangers from the Queensland Parks and Wildlife Service control any tree cutting or removal.

Pisonia Grandis is the dominant species in the cay forest. Usually occurring on small islands with large bird populations, this tree with its massive smooth trunk, brittle branches and dense canopy is endemic to Heron Island. It can reach a maximum height of 20m, but the trees on the site are not higher than 10m. Pisonia trees offer habitat to a number of seabirds, especially the Black Noddies which use the Pisonia leaves as nest material. The seabirds are vital to the distribution of the sticky seeds of these trees.[2] [3] >Fig.12

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[2] A.B. Cribb and J.W. Cribb, Plant Life of the Great Barrier Reef and Adjacent Shores (St Lucia: University of Queensland Press, 1985), pp.71-72, pp.164-168

[3] R. Murray (ed.), Proceedings of the Royal Society of Queensland (Volume 108) (St Lucia: Royal Society of Queensland Inc., 1999), pp.1-11

Fig.13 Black Noddy and Wedge-tailed Shearwater

Black Noddies (*Anous minutus*) and Wedge-tailed Shearwater (*Puffinus pacificus*), called Mutton Birds, are the dominant bird species on Heron Island. In contrast to the tree nesting Black Noddies, the Mutton Birds nest in burrows dug into the sandy soil. Their territorial behaviour on the ground is endangered by that of human occupation. Large parts of the site are no longer suitable for Mutton Bird nesting, because the soil has been compacted to provide smooth surfaces for paths, buildings and spaces to store equipment.[4] >**Fig.13**

Fig.14 Turtle

Finally, even the Green (*Chelonia mydas*) and the Loggerhead Turtles (*Caretta caretta*), the most endangered species on Heron Island, have to be considered in this design. Night lights need to be avoided as they attract both types of turtles as they go onto the beaches to lay their eggs. To ensure successful turtle breeding on Heron Island, building design needs to provide sufficient screening and appropriate forms of lighting.[5] >**Fig.14**

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[4] A.B. Cribb and J.W. Cribb, Plant Life of the Great Barrier Reef and Adjacent Shores (St Lucia: University of Queensland Press, 1985), pp.71-72, pp.164-168

[5] Maree M. Rosier, The Efficacy of Management Plans- Heron Island- a case study, The University of Queensland, 1992, pp.15-16

2_1_3 Current Infrastructure

The context of the research station consists of service facilities in the west, accommodation in the east and an operational complex in the centre. The three zones are interconnected by a central pathway with vehicular access and service pipes underneath. Fig.24 identifies the present circulation between the existing buildings. The different functions within the central part of the research station are indicated in Fig.23.

This project develops a proposal to replace the Roche laboratory building and the cabins next to the ablutions block. The target is to design new facilities that integrate the existing kitchen facility, the new teaching facility, the seminar building and the ablutions block and to interconnect them. Furthermore, the design has to consider the functional dilemma of the service facilities that serve both research and accommodation facilities.

The station relies completely on the electricity and water supply of the P&O Resort. Even the waste water treatment plant is provided by the resort. As there is no natural water available on the island, the resort runs a desalination system that provides for the water requirements of the entire island.
The electricity supply from two diesel generators is not only expensive in comparison to the mainland, but also limited and problematic at peak loads with the station remaining without power. The total electricity consumption for the site is composed of 31% for climate control, 26% for food storage, 15% for lighting and 12% for water supply treatment. The remaining 16% is used in administration, food preparation, construction, entertainment, cleaning, hot water supply and research.

This means that, especially for the high consumption areas, energy efficiency should be targeted.[6]

2_1_4 Site Analysis Schemes

Please see the schemes in Fig.15 – 25.

[6] Jody Finsen and Trent Whyte, Integrated Energy Systems (IES), Heron Island Research Station Upgrade- ESD and Energy Management, March 2003

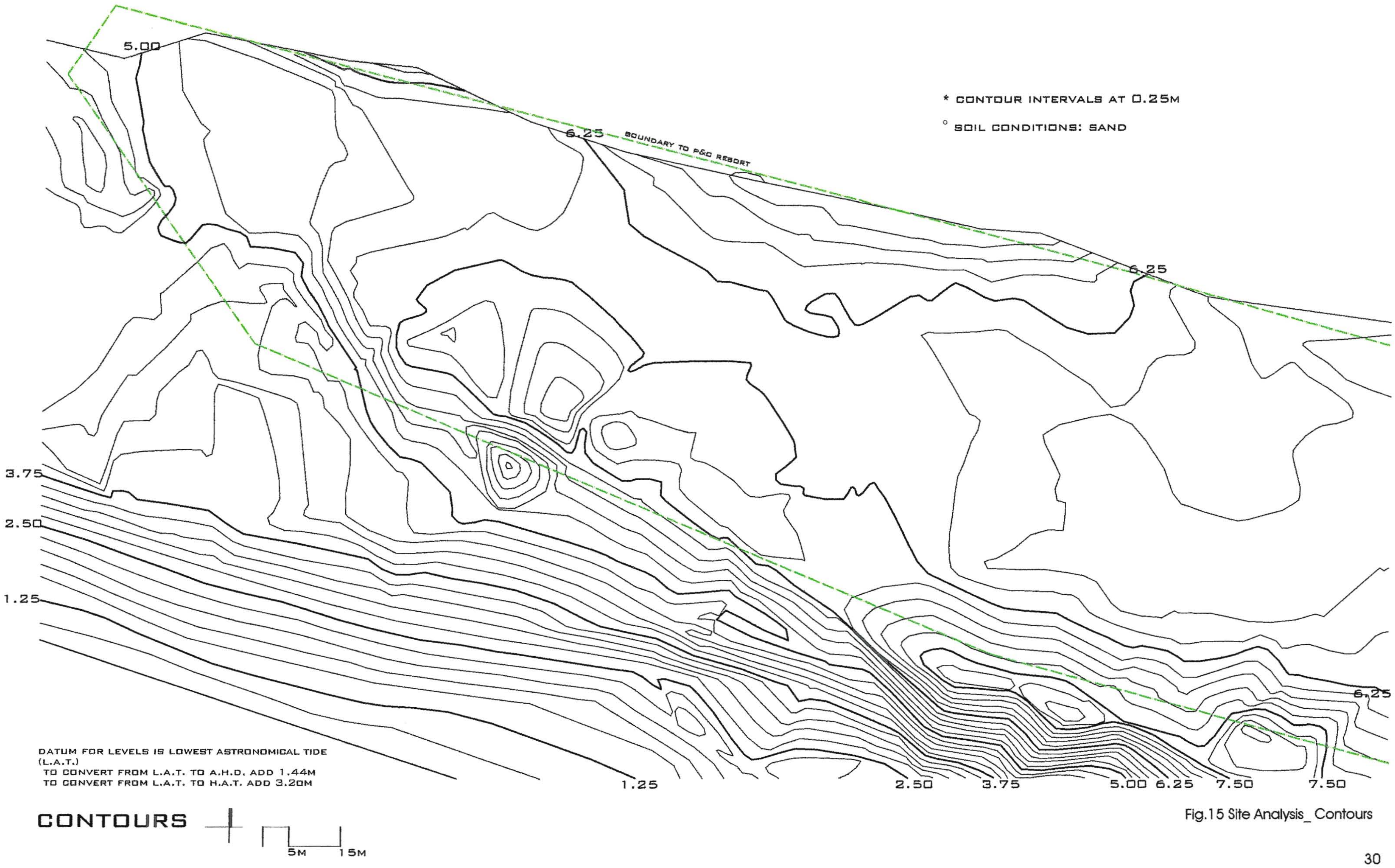
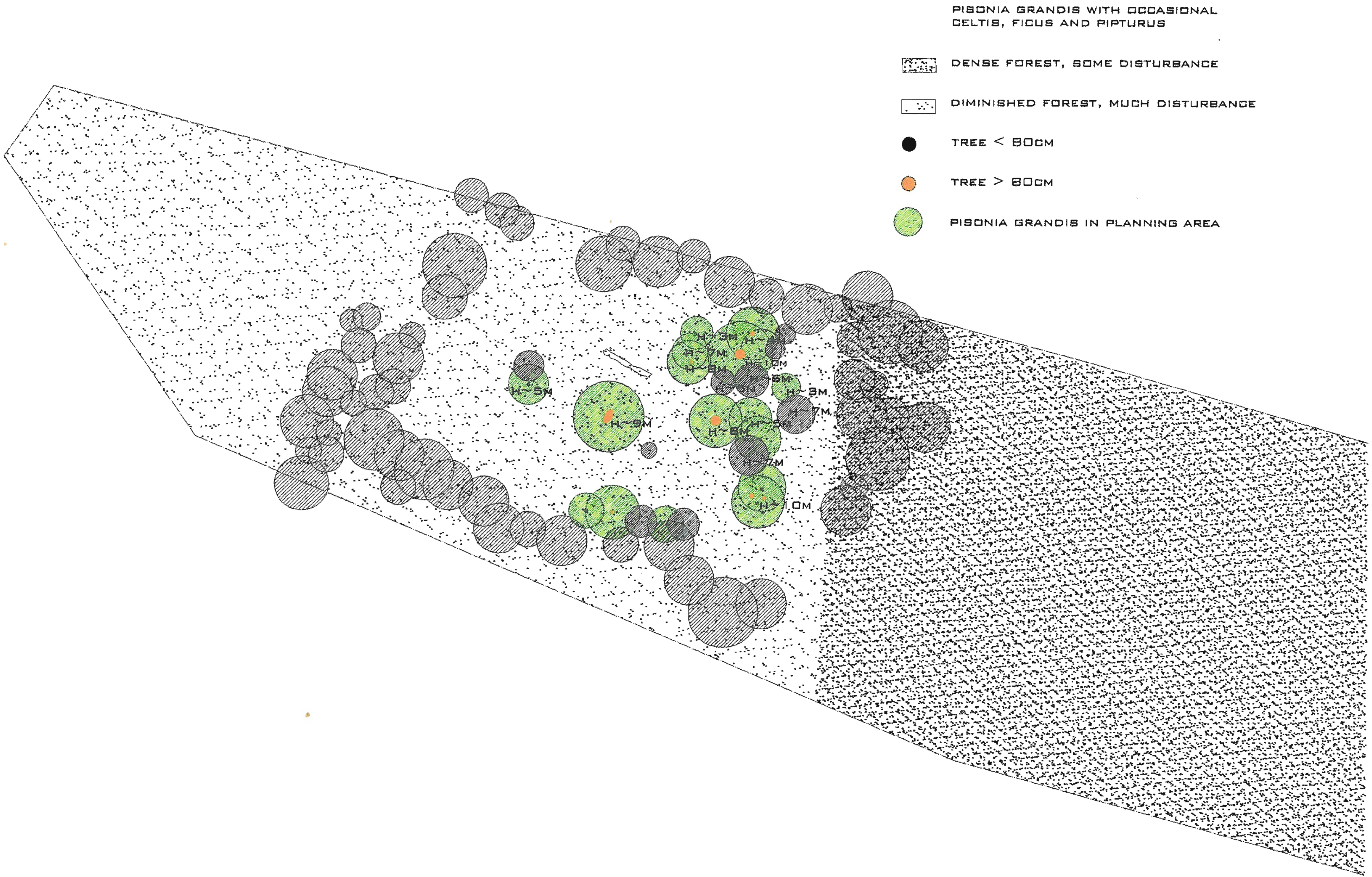


Fig.15 Site Analysis_ Contours



VEGETATION

5M 15M

Fig.16 Site Analysis_ Vegetation

Fig.17 Site Analysis_ Wildlife

Fig.18 Site Analysis_ Soil

ZONES:

- SERVICE ZONE
- OPERATIONAL ZONE
- ACCOMODATION

1_ DIVING STORE
2_ BOATSHED
3_ MAINTENANCE
4_ LAUNDRY
5_ RECEPTION/ OFFICE
6_ CHEMICAL STORE
7_ DINING
8_ KITCHEN
9_ BARBEQUE
10_ TEACHING
11_ WET LAB
12_ COOL ROOM
13_ AQUARIUM
14_ STORE
15_ LABORATORY
16_ AQUARIUM
17_ AMENITIES
18_ CABINS
19_ STAFF CABINS

EXISTING

5M 15M

Fig.19 Site Analysis_ Existing

Fig.20 Site Analysis_ Circulation

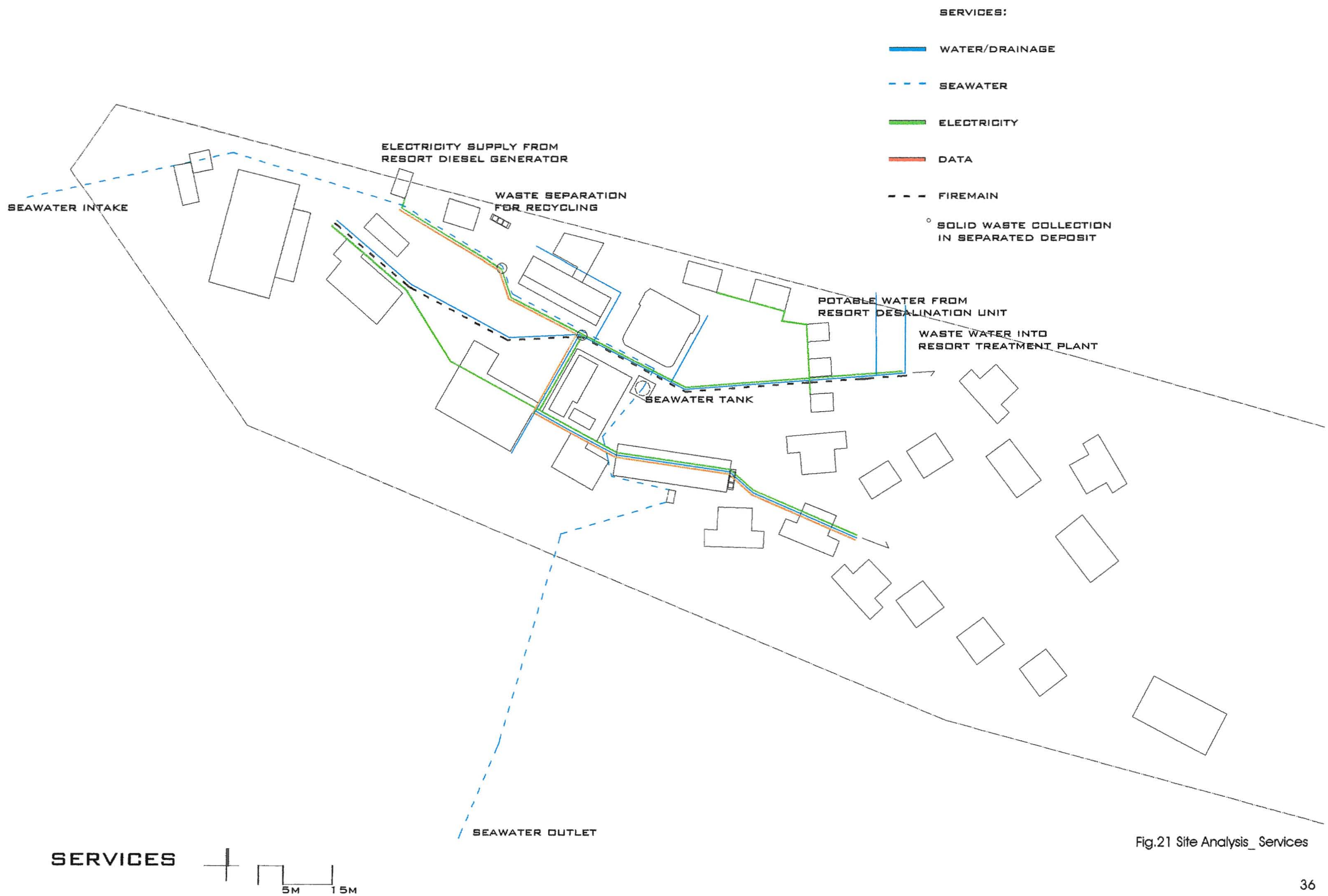
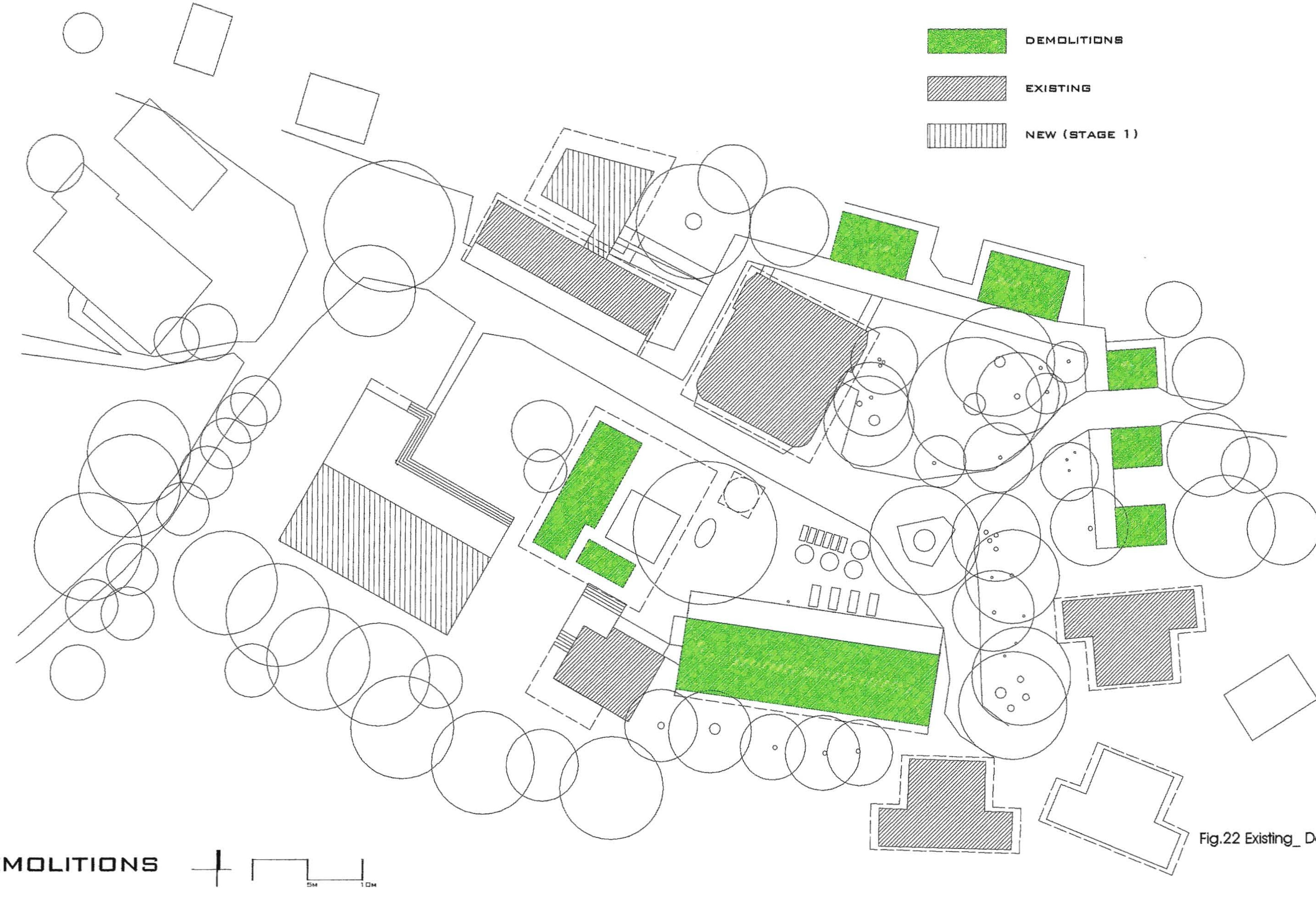


Fig.21 Site Analysis_ Services



DEMOLITIONS

Fig.22 Existing_ Demolitions

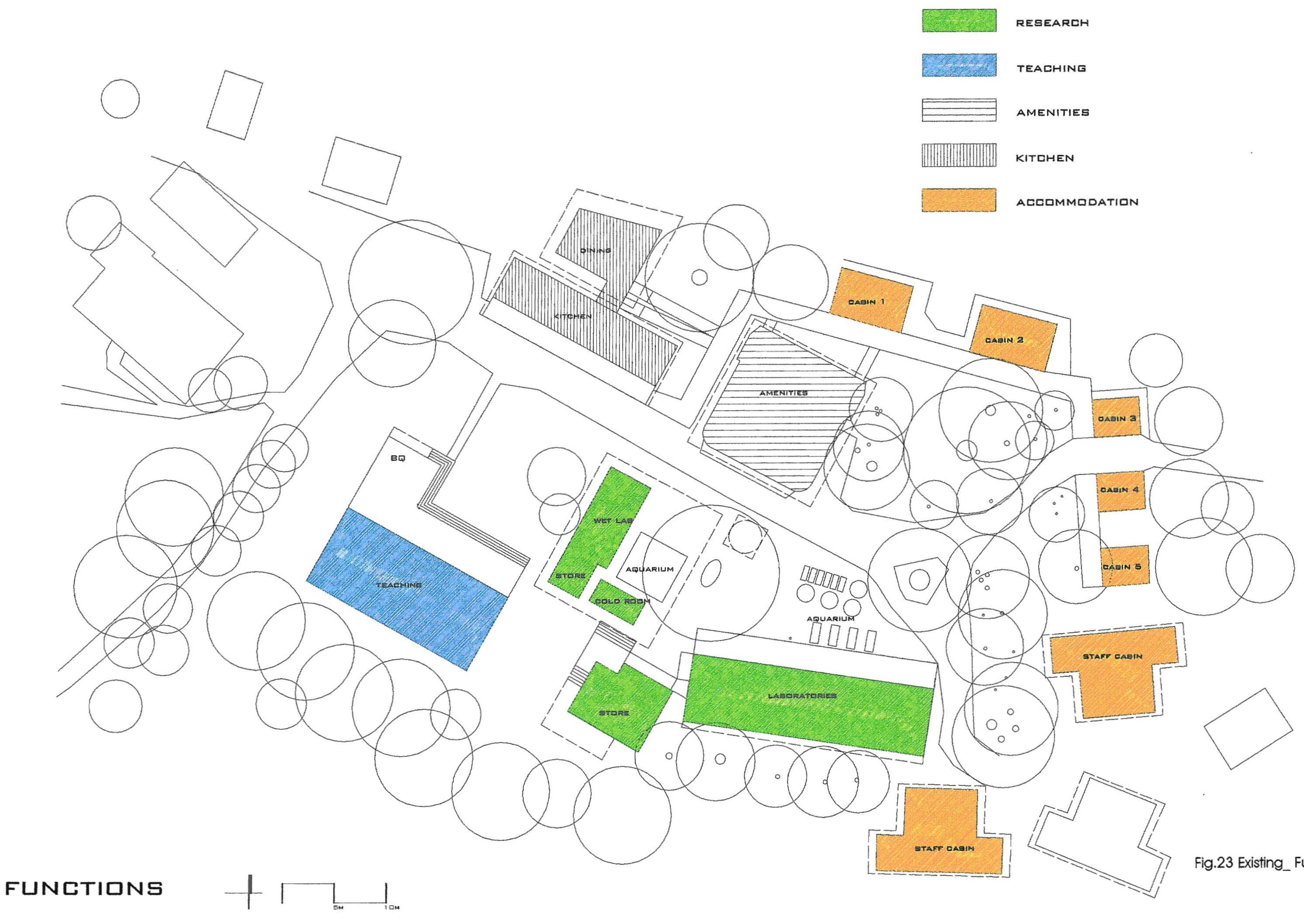


Fig.23 Existing_ Functions

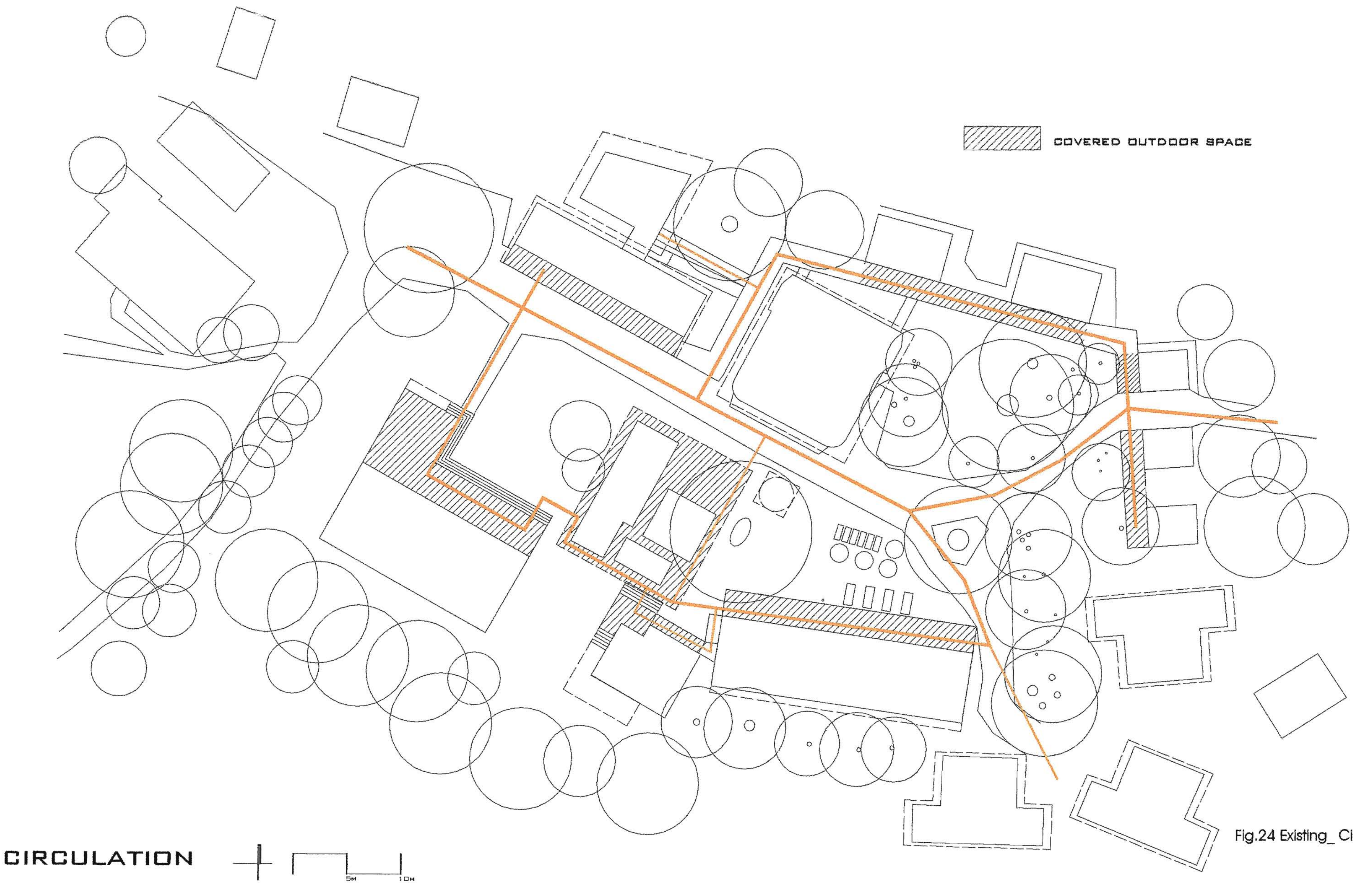


Fig.24 Existing_ Circulation

Fig.25 Site Analysis_ Overview

2_2 Case Studies

The site analysis emphasizes three principal design issues for Heron Island: firstly, the design has to cope with the *remote location* of the project; secondly, the environment of the design within a very *sensitive natural context* needs to be considered; and thirdly, the design should offer an appropriate approach towards the *hot humid climate*.

The projects analyzed below comply with most of these characteristics and show a range of exemplary designs influenced by and adapted to similar environmental conditions.

> Projects in remote locations:

1. House for a writer, remote island (Queensland), 1997
   – Tone Wheeler
2. Eco-trekking Lodge, Bay of Fires (Tasmania), 1999
   – Ken Latona

> Projects in a sensitive environment:

1. Kingfisher Bay Resort and Village, Fraser Island (Queensland), 1993
   – Gymer Bailey Pty Ltd
2. Daintree Wilderness Lodge, Daintree River Valley (North Queensland), 1991
   – Anna Graham

> Projects in a hot humid climate:

1. Marika-Alderton House, Eastern Arnhem Land (Northern Territory), 1994
   – Glenn Murcutt
2. Sunshine Coast University Library, Sippy Downs (Queensland), 1997
   – John Mainwaring & Lawrence Nield

2_2_1 Remote location

Heron Island is a small sand coral cay approximately 70 km offshore from Gladstone. **Transport limitations** need to be taken into account as the island can only be reached by barge or helicopter. Only smaller vessels can enter the channel that was blasted into the reef and which leads to the artificially created harbour. The design of the research facilities should consider the problems of transport in the choice of construction system and materials to avoid on-site construction waste and energy expense.

Apart from the transport issue any planning on Heron Island needs to respond to the **lack of resources**. Buildings should be designed to be self-sustaining. As there is no natural water available on the island, rainwater collection strategies are important. Renewable energy can be generated by sun and wind.

Fig.26 House of a writer

In a similar contex,t the Sydney architect Tone Wheeler established the 'House of a writer' on a solitary, tropical island in Queensland in 1997. The retreat is designed to be fully autonomous and environmentally efficient in its remote and sensitive location.

Sheltered by existing vegetation which filters the prevailing winds, the building is north-south oriented and opens to the east and west, allowing views of the ocean and catching the south-easterly breezes through the split roof. Tree shading and large roof overhangs limit the solar penetration on the western side of the house.

Responding to the hot humid climate, the building makes maximum use of the breezes using no other than passive design strategies to provide cooling. Cross-ventilation and exposure to the breezes are emphasized by an elevated design and the linear building form. The roof design enhances stack ventilation and provides shading on the building envelope. Finally, the design of the walls, with an

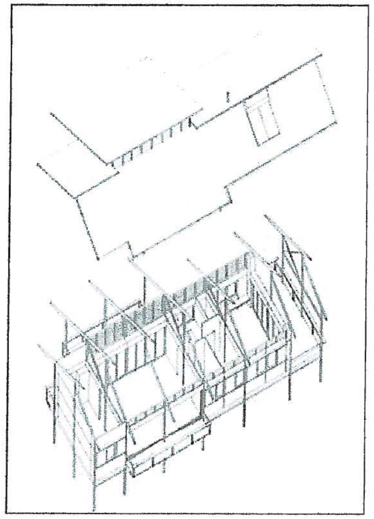


Fig.27 Construction House of a writer

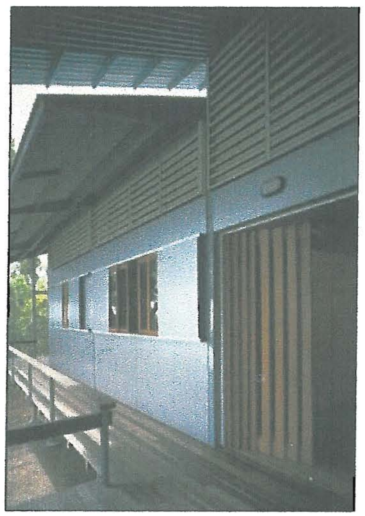


Fig.28 Envelope House of a writer

integrated louvre system and full-width sliding doors, ensures that cross-ventilation contributes to thermal comfort.

The most particular characteristic of the house is the layered envelope consisting of different sliding elements. Aluminium shutters provide security and cyclone protection; insect screens and glass doors allow for changing weather conditions; and the openness of the internal living space extends to the adjacent verandah. Including this envelope detail, the construction of this building is very simple and unspectacular. Following a 900 mm modular design, standard material sizes were utilized throughout the building. All components were prefabricated off-site and transported to the island by barge, so that construction waste on-site could be avoided and waste at the factory was minimized. The basic elements of the building are a bolt assembled steel structure, resistant to both cyclones and termites, corrugated steel sheet roofing and hardwood floors. Lightweight, high strength modular panels, lined with aluminium externally and plantation grown plywood internally, were used for the walls. Appropriate insulation was applied to the roof and walls.

The following strategies allowed to establish a self-sufficient house: a remote area power supply system with photovoltaic panels generates the power for electronic devices and lighting; rainwater is collected from the roof into large tanks that store the water during the wet season and provide a water supply in periods of less rainfall; and water is conserved by composting toilets and waste water recycling.[7] [8] This remote building is self-sufficient by necessity in the same way as the accommodation project which follows.

[7] Commonwealth of Australia, Home - Design for lifestyle & the future, 7.4a Case Studies: House - hot humid – remote, 2001
[8] Peter Skinner, Pragmatics for Paradise, Architecture Australia (September/October 1997), pp.62-67

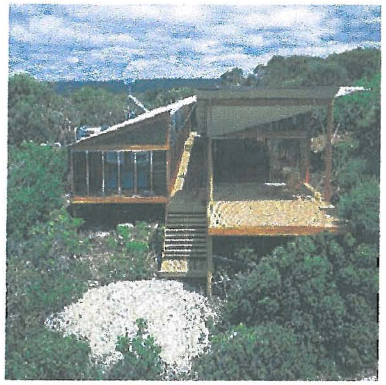


Fig.29 Bay of Fires Lodge

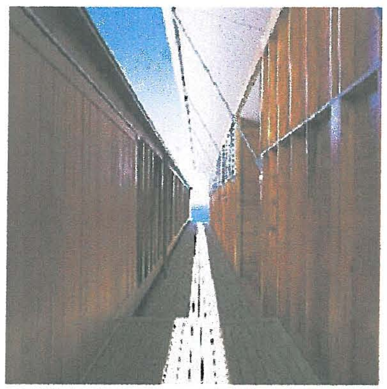


Fig.30 Corridor Bay of Fires Lodge

At the Bay of Fires in Tasmania the architect Ken Latona designed an eco-trekking lodge that is located in a remote area of the Mt William National Park. The lodge, built in 1999, sits between forest and coast on a hilltop overlooking the isolated beaches of the bay. It is the only building in the 20 km coastline and offers shelter for people undertaking guided tours through the wilderness of this unique natural environment. Rory Spence claims that the building retains some of the character of camping, but with greater comfort.[9]

The building consists of two long, parallel timber and glass pavilions linked by a narrow corridor that frames a spectacular view towards the sea. Hardly visible from the forest, they are sited right on the ridge of the hill "allow[ing] maximum connection to the landscape with minimum impact on the environment."[10]
The construction process reflects this attitude with both pavilions being placed on naturally cleared areas. Helicopters were used to transport the materials to the location before being carried to the site by hand. Tasmanian hardwood and plantation pine were the principal materials used. The pavilions are built on a 3x5m structural module. The timber frame construction unifies a skillion roof with stud framed single skin walls on treated pine stumps. The entire construction expresses simplicity and functionality with minimal detail.

The accommodation pavilion is functionally divided from its counterpart, which provides communal space with kitchen and dining facilities. Social areas extend onto outdoor decks that offer views towards both the forest and the beach.
Equipped with a modern grey water treatment plant, composting toilets and rainwater tanks, as well as solar collectors on the roof, the building is planned to be autonomous and responds to the requirements of sustainability.

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[9] Rory Spence, Sublime Camping, Architecture Australia (July/August 2000), pp.40-47
[10] http://www.bayoffires.com.au/firefrme.html, 13.06.2003

Fig.31 Verandah House of a writer

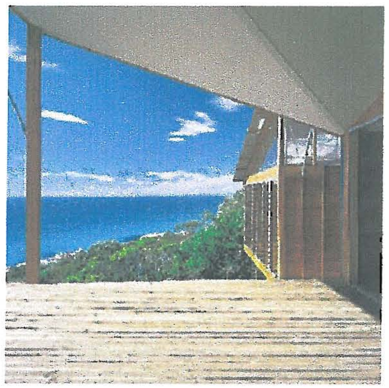

Fig.32 Deck Bay of Fires Lodge

Both remote projects show the same design issues- the overall **simplicity of the structure** made of prefabricated elements and the building's **autonomy** by using renewable resources.

The 'House of a writer' is a pragmatic design deriving straight from the site conditions. The spaces created are pure, ready to be filled with life and character. The building does not compete with its spectacular setting. Comparable to the writer's white initial page, the retreat is a place to clear the mind before starting a new story. Its constructional simplicity is not only a consequence of remote building but also a conceptual tool to create a space for thinking.

The basic timber construction of the Bay of Fire Lodge, on the other hand, achieves similar architectural goals. Beside its rigid functionality as a shelter and place of social exchange, the space created offers an extraordinary architectural experience. The unpretentious construction erected the pavilions with minimum impact on the environment, without delays due to complicated construction procedures. The intensity of the natural setting enhances the visitors' education and reflects the philosophy of both the National Park management and the tour operator,indicating the greater priority given to environmental conservation over human demands:

> From the siting of the buildings and the form of their design to the selection of building materials and the management of the construction process, our single focus has been on protecting the landscape and connecting to it.[11]

[11] http://www.bayoffires.com.au/firefrme.html, 13.6.2003

2_2_2 Sensitive Natural Context

The natural environment on Heron Island is unique and, as a part of the Great Barrier Reef, was declared to be a National Park more than 50 years ago. Building in this extremely fragile ecosystem needs to consider the risks and **impacts of construction**. Precautions have to be taken to avoid damage caused by the construction process and even by the remains of the abandoned building.

Heron Island and its marine environment are well-protected, but nevertheless subject to extended tourism. It is therefore important to inform visitors about adequate behaviour and strategies for sustainable co-living on the island. The building design should address these **educational aspects** and motivate users to enjoy the place without leaving permanent footprints.

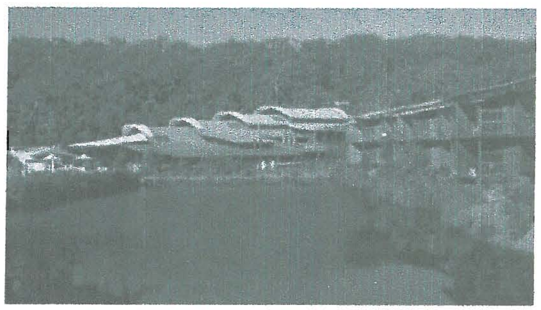

Fig.33 Kingfisher Bay Resort and Village

The Kingfisher Bay Resort and Village on Fraser Island, designed by Guymer Bailey Pty Ltd and completed in 1993, show an interesting strategy to create a tourism facility with minimum site disturbance. The complex is located in an island environment that is included on the international World Heritage register. The aim in the design of this project was to show best practice of ecologically sustainable design regarding site sensitivity and the choice of materials.

The resort complex comprises a facility with support structure, accommodation units and self-contained villas. To minimize the impact of this relatively large-scale project on the local eco-system, the site planning for the accommodation emphasizes fragmentation. Transportation limits excluded a conventional concrete construction. The entire complex was elevated on treated pine piles that penetrate deep into the sandy soil.

The most interesting are the accommodation units, which are paired together in such a way that they form a central space for access and ventilation. The pine

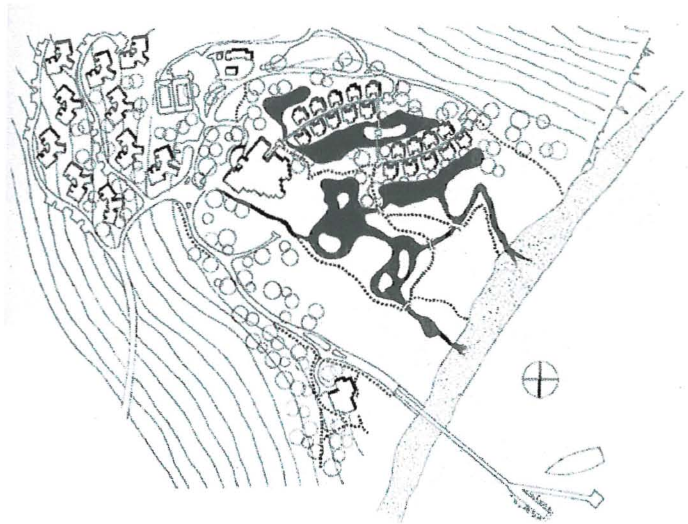

Fig.34 Kingfisher Bay Resort General Plan

piles support a timber construction with framed walls and floors. Cladding is made of hardwood weatherboards, the lining of plasterboard and the flooring of plantation pine plywood. Only the roof of curved, corrugated steel sheeting and the standard aluminium windows and doors stand out in these timber buildings.
The design for the individually air-conditioned accommodation units provides for easy maintenance and, above all, the possibility of deconstructing the buildings to the point that only the pine piles remain which, well buried into the sand, would auto-destroy themselves within time. Lawson claims:

> At some time in the future, the function of the buildings as a tourist resort may be deemed to be incompatible with the World Heritage qualities of Fraser Island on account of environmental degradation associated with visitor activities [...] If this were ever to happen and a decision was made to demolish the resort, then the accommodation buildings, at least, can be dismantled with minimal demolition impact on the environment and many of the components can be salvaged for reuse elsewhere.[12]

Moving from Fraser Island to Cape Tribulation we find another good example which demonstrates how a building and its function can be adapted to the natural environment.

The Daintree Wilderness Lodge is located approximately 120km north of Cairns, adjacent to the Wet Tropics World Heritage region of Cape Tribulation. Built in 1991 by its owners, the lodge was established to accommodate visitors mostly from overseas who come to explore the Daintree River Valley, which is one of the largest rainforest areas in Australia, providing habitat to many endangered species.

[12] Bill Lawson, Building Materials, Energy and the Environment (Red Hill: The Royal Australian Institute of Architects, 1996), pp.69-73

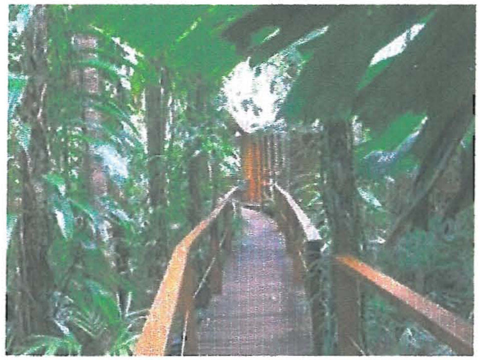

Fig.35 Daintree Wilderness Lodge

Fig.36 Daintree Wilderness Lodge Pool

The lodge is designed to offer an educational experience to its guests. It comprises a number of bungalows which are placed into the rainforest canopy, suggesting the living with the animals and presenting fantastic views for rainforest observations from their verandahs. Elevated walkways with service pipes fixed to the underside connect the bungalows and ensure that the ground cover can continue without disturbance. The low-impact construction in plantation pine timber was built around the existing vegetation. Necessary clearing was carried out by hand and, by building the raised boardwalks first, the building material could be moved to the site without the use of machinery and without creating further impact on the rainforest floor.

Guided, interpretive bush walks, touch tables and descriptive folders and videos provide the guests with plenty of information not only about the local flora and fauna, but also about the existing policies to protect the fragile environment. Further information is given on the environmental lodge management which explains behaviour-related issues, such as the necessity for water conservation and appropriate garbage disposal.[13]

Comparing both projects, one realizes that different design issues concerning the uniqueness of their natural environments have been addressed.

Purposely built as a temporary construction, the Kingfisher Bay Resort design offers another remarkable approach to sustainable design. It may one day be deconstructed in the ultimate attempt to comply with the principles of environmental sustainability.

The Daintree Wilderness Lodge, on the other hand, is an exemplary project for environmental education. The accommodation experience is part of an

[13] http://twinshare.crctourism.com.au/CaseStudies/Cs4.htm, 13.6.2003


Fig.37 Kingfisher Bay Resort Accommodation


Fig.38 Daintree Wilderness Lodge Accommodation

environmental excursion into the rainforest life and demonstrates that a building can exert a strong influence on people's attitude towards nature.
The enormous scale difference of both types of accommodation does not stand in contrast to their common design feature, the **low-impact construction**. The resort complex, as well as the lodge buildings, are elevated constructions with low-impact foundations. "Touch[ing] the earth lightly"[14], interference with existing ground habitats has been avoided in both cases.

2_2_3 Hot Humid Climate

The climate on Heron Island is influenced by both the subtropical and tropical zones. The average temperature levels are close to the comfort zone throughout the year. High humidity and low diurnal temperature ranges necessitate **cooling strategies**, especially during the summer months. Constant sea breezes contribute to thermal comfort. Situated on the Tropic of Capricorn, the island is subject to frequent **cyclones** which cause strong winds and intense rainfall in the three or four months of the wet season.

The Marika-Alderton House, designed by Glenn Murcutt and completed after a long planning process in 1994, is located in the Eastern Arnhem Land in the Northern Territory. Built for an Aboriginal family, the simple, but well-planned structure protects from sun, insects and rain and reflects the aboriginal relationship with the land.
Confronting a tropical climate with extremely high temperatures and humidity, this house can be completely opened up. Both ends of the elevated, linear building

[14] Quoted by Glenn Murcutt and title of his biography (Philip Drew, Touch this Earth lightly: Glenn Murcutt in his own words (Potts Points: Duffy & Snellgrove, 2001))

Fig.39 Marika-Alderton House

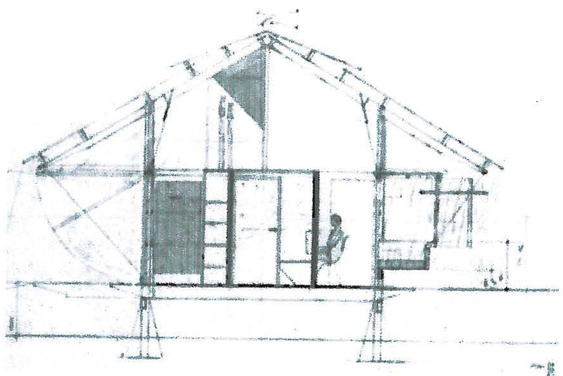

Fig.40 Drawing Section Marika-Alderton House

are oriented towards the prevailing breezes. The north and south facing, long facades consist of plywood flaps and timber batten screens that can be manipulated according to the shading and ventilation requirements. Cross-ventilation is optimized by the thin plan.

The blades and screens are designed so that openness and privacy can be achieved at the same time. Large roof overhangs to the long sides provide shading and protection from extreme rainfall. The prefabricated structure is composed of a steel frame with Australian plantation grown hardwood and complies with region specific cyclone codes. The conventional program of a family house with living and dining area, children's and parents' bedrooms allowed to establish a reinforced bathroom block for cyclone protection. Exhaust fans in the roof provide stack ventilation and serve to balance the air pressure in the building during cyclones.[15]

Beck compares the characteristics of the modifiable enclosure to those of a tent:

> ... when the flaps (like those of a tent) are raised, the division between inside and outside is almost entirely dissolved. This is not a metaphor imposed by the designer, but one that arises out a solution to climatic conditions.[16]

In contrast to this passive design in the tropics, the Sunshine Coast University Library in Sippy Downs, designed by Lawrence Nield and John Mainwaring in 1997, is an interesting example of an air-conditioned public building in a subtropical climate. The library block is the central part of a new campus on the Sunshine Coast. Located on an east-west axis with views towards a near lake and the adjacent fields, the architects moved the building sideways to provide it with a breezeway verandah on its northern side. Screened by a collage of sunbreaking timber slats, the elevated verandah space frames the views of the surrounding landscape and

[15] Haig Beck and Jackie Cooper, A singular architectural practice (Mulgrave: The Images Publishing Group Pty Ltd, 2002), pp.131-141
[16] Haig Beck and Jackie Cooper, Insideout, UME 15, 2002, pp.8-9

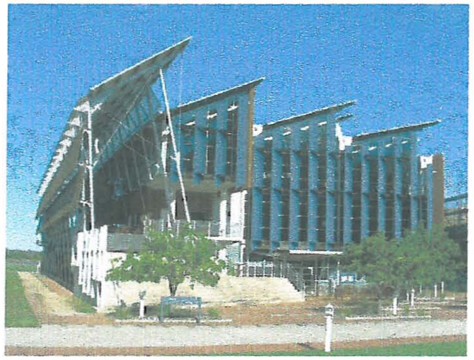

Fig.41 Western Elevation Sunshine Coast University Library

Fig.42 Eastern Elevation Sunshine Coast University Library

catches the northeast sea breezes in summer. Matching the entrance level on the first floor, the verandah offers a well-ventilated outdoor sitting area for students socializing and relaxing from their studies.

The other function of this extended verandah concerns the shading. The dense screening elements were essential to open up the library walls and use a highly glazed external skin to allow daylight and outside views. Forming a buffer space the verandah protects the air-conditioned library building from solar access and reduces glare and heat loads.

The northeast oriented building is characterized by its layered construction and dynamic composition of materials. Steel structure, timber screens, plywood walls and corrugated steel sheet cladding and roofing, all continuous facade elements, are unified under an extravagant set of skillion roofs, which refer to local historical precedents. [17] [18]

The projects from above demonstrate a tropical and a subtropical climate response to distinctive functions and scales.

Regarding the Marika-Alderton House, the design for natural ventilation is predominant. The prefabricated house can be totally open with its opening elements modulating air-flow and shade. The interior can be turned into the exterior to heighten thermal comfort.

The library building, on the other hand, is a sealed, actively air-conditioned block. Although the interior conditions are artificially induced, the shading facades prove that the climate has been considered in the design. The screen devices, in combination with the breezeway, reduce heat gains into the building and decrease energy use.

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[17] Davina Jackson and Chris Johnson, Australian Architecture Now (London: Thames & Hudson Ltd, 2000), pp.168-173

[18] Peter Hyatt, Local Heroes (Sydney: Craftsman House, 2000), pp. 150-155

Fig.43 Envelope Marika-Alderton House

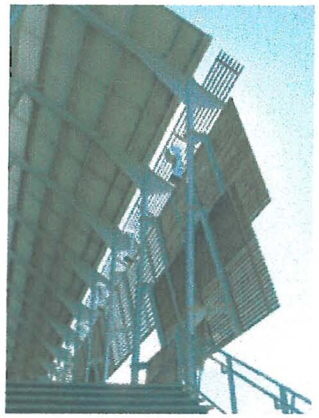


Fig.44 Envelope Sunshine Coast University Library

To conclude, these projects confirm that **ventilation and shading** are the primary cooling strategies for subtropical and tropical climate zones. In spite of the contrasting designs, the relationship with the surrounding natural environment and the climate has been emphasized in both building designs.

2_2_4 Conclusion

Regarding the characteristics that influence construction on Heron Island, the six references point out significant factors for an appropriate building design.
The two examples for remote building show very clearly that the structure and its construction process need to be kept simple. The **simplicity** is a direct response to the limitations. Materials, machinery and labour have to be transported to the site over long distances. This requires a building design that is based on prefabrication which again involves modularity and the use of standards. To facilitate transport, the building components should preferably be of small size and lightweight.
In addition to this, the construction process and later building operations in remote areas cannot rely on infrastructure and services. The building needs to be designed for **self-sufficiency**. Renewable energy can be generated from sun, wind and even water. Responsible water and waste management, which includes recycling, completes the autonomy of the building.

As for the two projects that demonstrate very different responses to being located in unique, delicate and therefore protected environments, it is obvious that the **impact** of construction must be minimized. Firstly, it is necessary to find out what exactly makes up the impact on the specific site. Having analyzed the predominant problems, the building footprint becomes an important indicator for the sensitivity of the design. The footprint can be minimized by avoiding excavation work and by elevating the building above the ground, setting it on posts with low-impact foundations. The material choices for the different construction components are decisive. This leads back to the previous point which describes the necessity of an off-site fabrication and shows how the different factors are interconnected.

Our case studies demonstrate that the impact of a building can be reduced in many different ways. On the one hand, there is the example of the tourism facility that is designed to be deconstructable, which is confirmed in the material choice of timber as a natural, auto-decomposing material and the flexible assembly design. The accommodation design in the rainforest, on the other hand, focuses on the impact of the building's users. The educational strategy comprises the design of outdoor experiences within the natural setting and of interpretive structures for display and interaction.

In relation to the climatic design for the hot humid zone, both case studies point out the basic strategies for achieving thermal comfort in a building. There is the passive design of a family house in contrast to the active design of an air-conditioned library building which, again, relates back to both energy efficiency and the building's impact described in the preceding section. Firstly, the study of both designs shows that **ventilation and shading** are the two strategies that make up a sub-/tropical building design, whether active cooling methods are applied or not. Both ventilation and shading depend on orientation, forms and openings which influence air-flow or sun penetration. In respect to these parameters for thermal comfort, it turns out that passively designed buildings in the hot humid climate invite the creation of indoor-outdoor spaces.

2_3 Risk Management

The case studies make clear that there are well-known and broadly applicable strategies for designing in the hot humid climates and remote locations. However, to resolve the conservation issue which is predominant on Heron Island, further research is required to develop strategies for a precautionary design that protects this unique eco-system and minimizes possible damage. Regarding the impact on the local biological community, in contrast to the impact on the broader environment, three main hazards can be identified:

> the displacement and extinction of native fauna,
> the degradation and extinction of local flora
> and the degradation of soil.

The risk assessment demonstrates that noise and movement by people and machinery influence birds nesting on the island. Exposed night lighting has serious consequences for the survival of endangered turtle species. The risks for the native vegetation lie in plant removal and other construction related activities. Soil degradation comprises compaction, contamination and erosion induced by trampling, machinery, underground works and toxic materials.
Valuating the likelihood and consequences of these hazards, special attention needs to be paid to the lighting problem and the degradation of vegetation and soil, which are both important bird habitats. Furthermore, a strong interdependency of the different hazard factors can be noticed.[19] >Tab.3

[19] Risk management adapted from Australian Standard AS/NZS 4360:1999

Tab.3
_ risk assessment>

for building interventions @ Heron Island Research Station

impacts on the broder environment

impacts on the local biological community >

_ issues			_ prioritisation			_ management
hazard	cause	factors	likelihood	consequence	risk ranking	mitigation
displacement and extinction of native fauna						
noise and movement	machinery and vehicles, worker and user, equipment	birds, esp. surface nesting species (terns + waders) and Mutton birds	medium	medium	medium	prefabricated assembly structure for rapid erection by local labour, avoidance of machinery
light	exposed night lighting	turtles + hatchings	high	extreme	high	building orientation, sodium lighting, screening devices
degradation and extinction of native flora						
plant removal and destruction	trampling, on-site storage, construction	trees, esp. *Pisonia* and lower understorey vegetation, tree-nesting birds, esp. Black Noddies	high	extreme	high	elevated construction on posts, boardwalk circulation, avoidance of machinery, flexible building design, low impact foundations
soil degradation						
soil compaction	machinery footprint, trampling	ground-nesting Mutton birds and plants	high	extreme	high	lightweight composite system, elevated construction, boardwalk circulation, avoidance of machinery
soil contamination	toxic droppings, e.g.oil, paint construction remains, esp. footings	"	medium	high	medium	prefabricated building elements, use of 'green', non toxic materials, removable footing system, avoidance of machinery
erosion	foundations, pipeline constructions, underground tanks	ground-nesting Mutton birds and trees, esp. *Pisonia*	high	high	high	controled roofwater drainage, low impact foundations, avoidance of excavation works

evalutation scale:

_low
_medium
_high
_extreme

Part 3_ Project>

3_1 Concept

3_1_1 Aim and Objectives

The aim of this thesis and project is to develop appropriate architecture for Heron Island. The background research has shown that to achieve this aim three design issues have to be addressed:

- the hot humid climate,
- the remote location,
- and the sensitive natural context.

Consequently, the objectives of this project are to:

> create thermal comfort through a climate responsive and resource saving design,
> respond to the lack of resources introducing renewable energies,
> provide flexible structures for easy transport, construction and maintenance,
> design buildings and their construction in a way that biodiversity is conserved and prevent user impact through environmental education.

3_1_2 Strategies

Based on research and case studies, a set of possible strategies is identified to respond to these objectives. **Tab.4** lists the strategies appropriate for the design of this project. Summarizing the list, three principle strategies are used:

firstly, the architectural response for both structures implies an elevated low-impact construction with minimum footprint, simplified through modular design and prefabrication;

secondly, the design focuses on the human occupation of the building envelope and its interaction with climate and natural environment and therefore generating multiple social issues;

and thirdly, environmental requirements are addressed in the design of the buildings with the purpose of converting the research station into a largely self-sustaining facility in the future.

Tab.4

_ concept>	_ objectives	_ possible strategies		
hot humid climate	> max. thermal comfort > min. energy use > max. climate responsiveness	_ interactive envelope design _ cooling through active and passive shading _ low mass construction with appropriate insulation level _ passive cooling through cross-ventilation/ stack ventilation (building orientation, shape) _ intelligent design for air-conditioned spaces (zoning, insulation) _ use control mechanisms _ passive solar heating in cooler periods where appropriate	>	**architectural>** **elevated low-impact construction with minimum footprint, simplified through modular design and prefabrication**
remote location >distance	> min. transport > min. construction process and waste > min. maintenance > max. recycling	_ lightweight structure _ reduction of material sizes _ prefabricated assembly system (rapid erection by unskilled labour) _ use of standards _ durable, corrosion resistant materials _ cyclone proof structure _ deconstructable system _ use of recyclable materials	>	
>lack of resources	> max. use of renewable resources > max. conservation of resources > max. day lighting	_ solar energy use (photovoltaic and solar hot water system) _ provision of battery and grid connection _ resource efficient systems, equipment and fixtures (air-conditioning, lighting, sensors) _ thoughtful window and lighting design _ rainwater collection and storage	>	**social>** **interactive building envelope to establish human occupation within climate and natural environment**
sensitive natural context >construction impact	> max. conservation of biodiversity > min. footprint and built volume > min. construction and destruction impact	_ building on existing footprint/ previously degenerated areas _ maximum revegetation with native plant species _ elevated building construction _ two storey construction _ limitation of circulation space (elevated boardwalks) _ avoidance of excavation works and machinery _ low-impact foundations _ use of 'green', non-toxic materials with miniumum embodied energy _ careful lighting design (orientation, screening, low intensity sodium light) _ controled roof water drainage	>	
>user impact	> max. environmental education > max. responsible user behaviour	_ interpretive facilities and information _ environment-related, interactive building design _ programmation of user action through design (walkways)	>	**environmental>** **passive design with resource efficient devices for self-sufficiency**

3_2 Site Planning

With regard to the different parameters for each site and program, this project uses contrasting siting strategies: the fragmented design for the accommodation responds to the requirements of a densely vegetated site where trees have to be maintained and massive structures avoided; the laboratory facility, on the other hand, integrates into the existing centre in as compact a way as possible.

Fig.45 Compactness and Fragmentation

3_2_1 Site Planning Drawings

Please see Fig.46-48.

0.1_ accommodation and laboratory facilities @ HIRS _ general plan M1:500

Fig.46

Fig.47 Functions Scheme

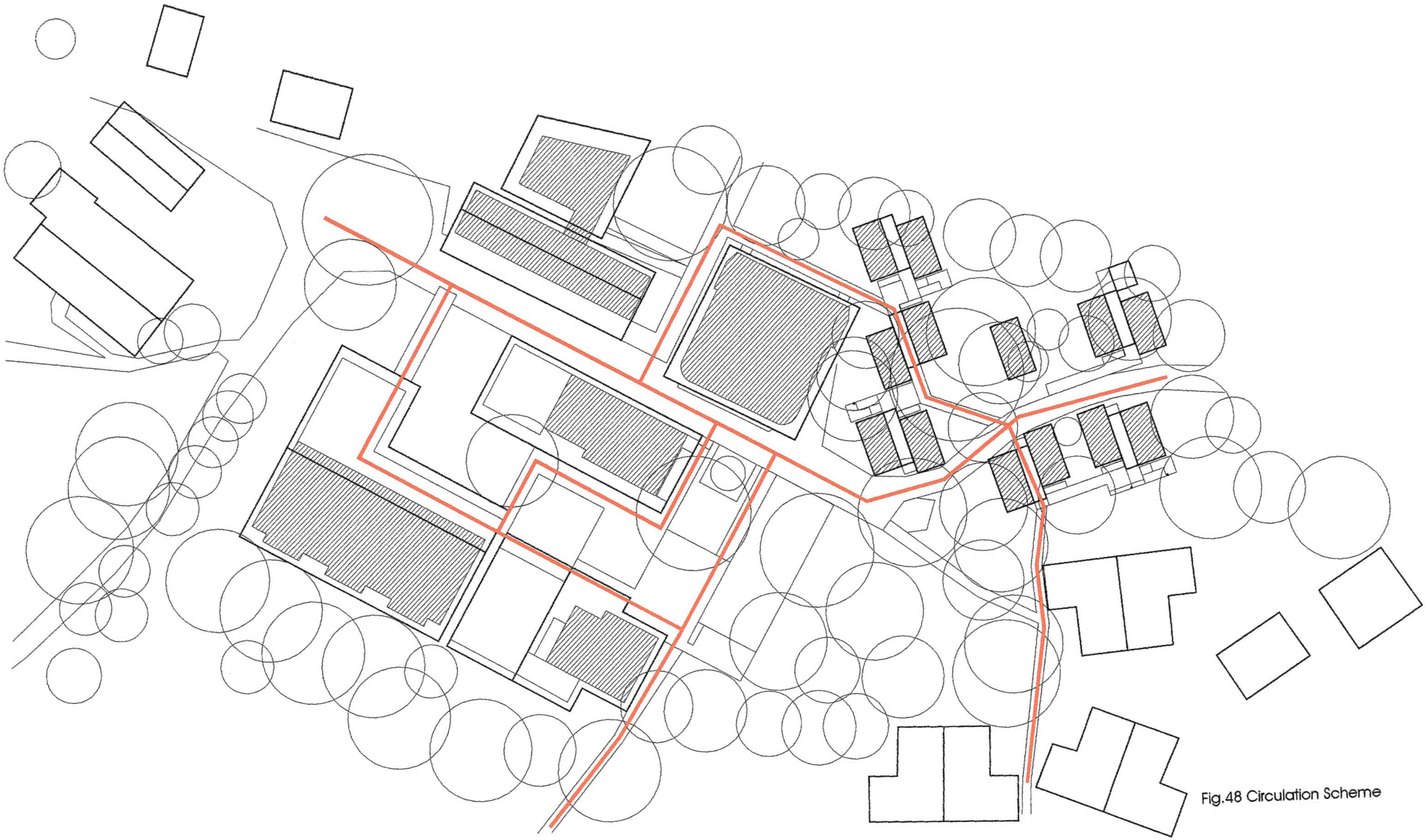


Fig.48 Circulation Scheme

CIRCULATION

3_2_2 Site Planning Accommodation

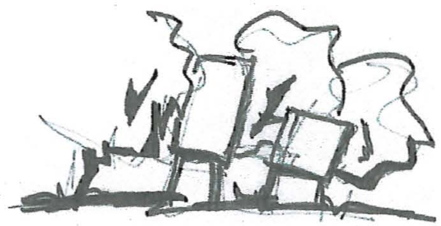


Fig.49 Sketch Accommodation

Beautiful, high-grown Pisonia trees overloaded with birds nests characterize the site for the new accommodation buildings. The trees offer broad shade and protection from storms, which is advantageous for the planning. Yet problematic is the fact that the density of vegetation reduces the effect of the prevailing breezes and that these trees are likely to drop branches due to their soft wood.

Initial designs attempted to locate the accommodation in an area of less ecological significance[1] and in closer proximity to related service facilities in the ablutions block and the kitchen building. However, the functional schemes confirm that the dormitories need to be erected near the amenities, at a reasonable distance from research areas and closer to the accommodation zone. With these constraints the design concentrates on the positive qualities of the site and focuses on the creation of dormitory space within the trees.

The fragmented design makes it possible to distribute the program over a set of six pavilions linked by an elevated walkway. The siting takes advantage of the natural clearing necessitating the removal of only one smaller tree. The pavilions plug into the existing voids and adapt their heights to the available space under the trees, which reduces the trimming of branches.

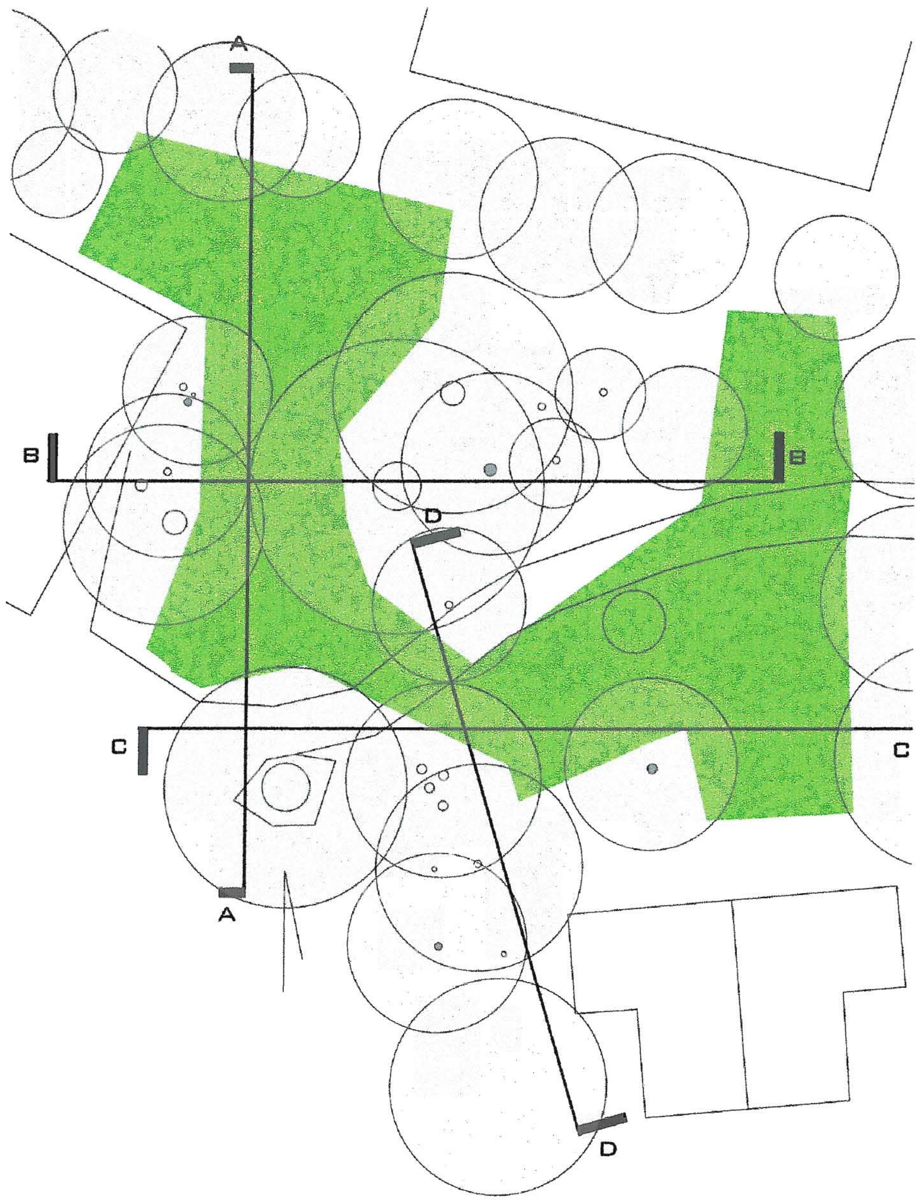
To minimize the footprint, the target is to establish as many two-storey pavilions as possible, always ensuring that the building height remains under the canopy level. Two different pavilion types connect to the walkway which leads towards the amenities in one direction and towards staff cabins and the beach in the other.

[1] Please see also part 2, 2_3 risk assessment

The first type is a one-storey dormitory which has the walkway running through, the second type is a two-storey building, located at the endpoints with platform space in front, which provides access to the staircase and seating for socializing. All the structures are post and beam constructions at about 1m elevated above the ground, so that excavation works are avoided and soil conditions maintained. To reduce circulation space and construction impact on the site most pavilions are situated adjacent to the existing path. The teacher's cabins are disconnected from the walkway located on the path and provide disabled access over a ramp. This design follows the footprint of previous cabins only in parts, because it became necessary to move the accommodation away from the boundary due to noise from the resort staff club. The height of the area near the boundary is limited by the trees and unsuitable for two-storey construction. Revegetated, the terrain regains its usual flora and fauna.

The pavilions follow a pattern that allows the prevailing breezes from southeast to filter freely through the site and the buildings. Tree shading protects the buildings from sun radiation and justifies their orientation for ventilation. The densely vegetated area near the boundary provides protection from cyclonic storms.

Please see Fig.50-53.



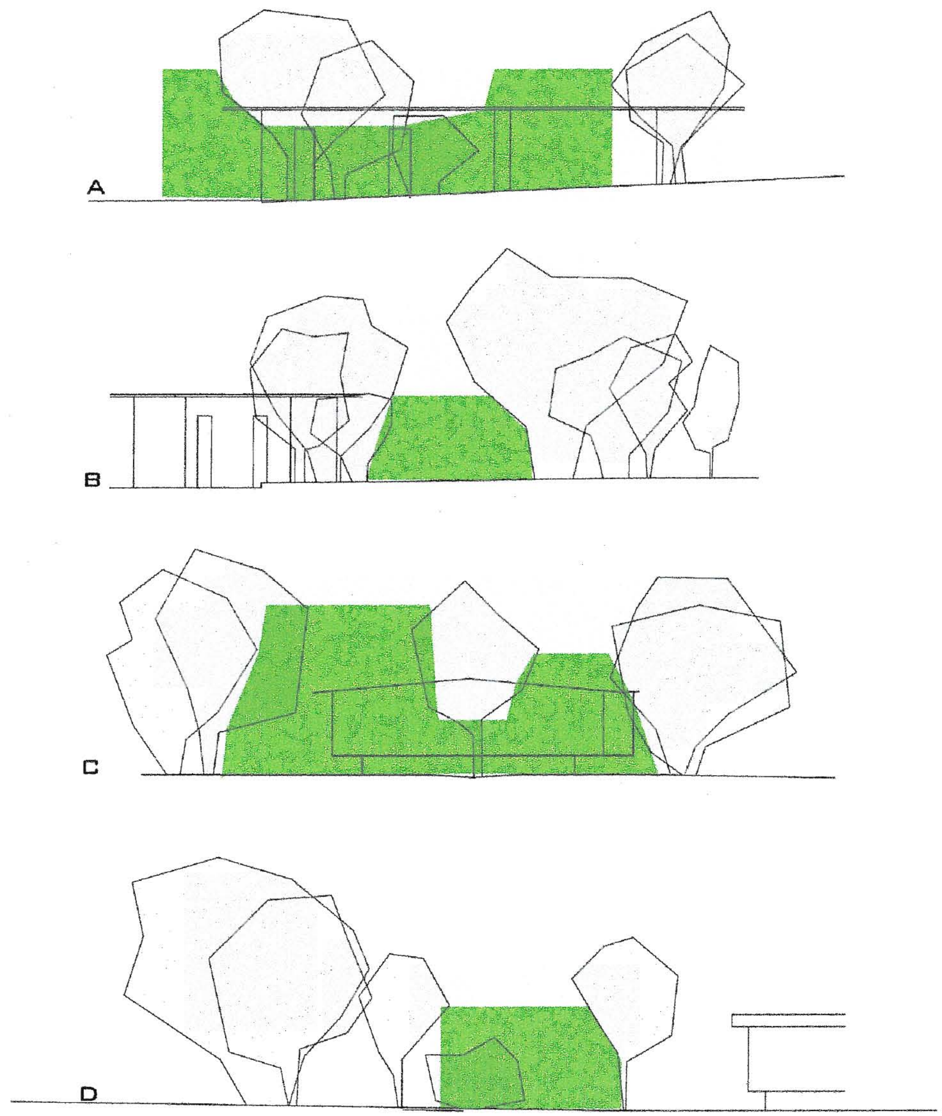


Fig.50 Natural Clearing

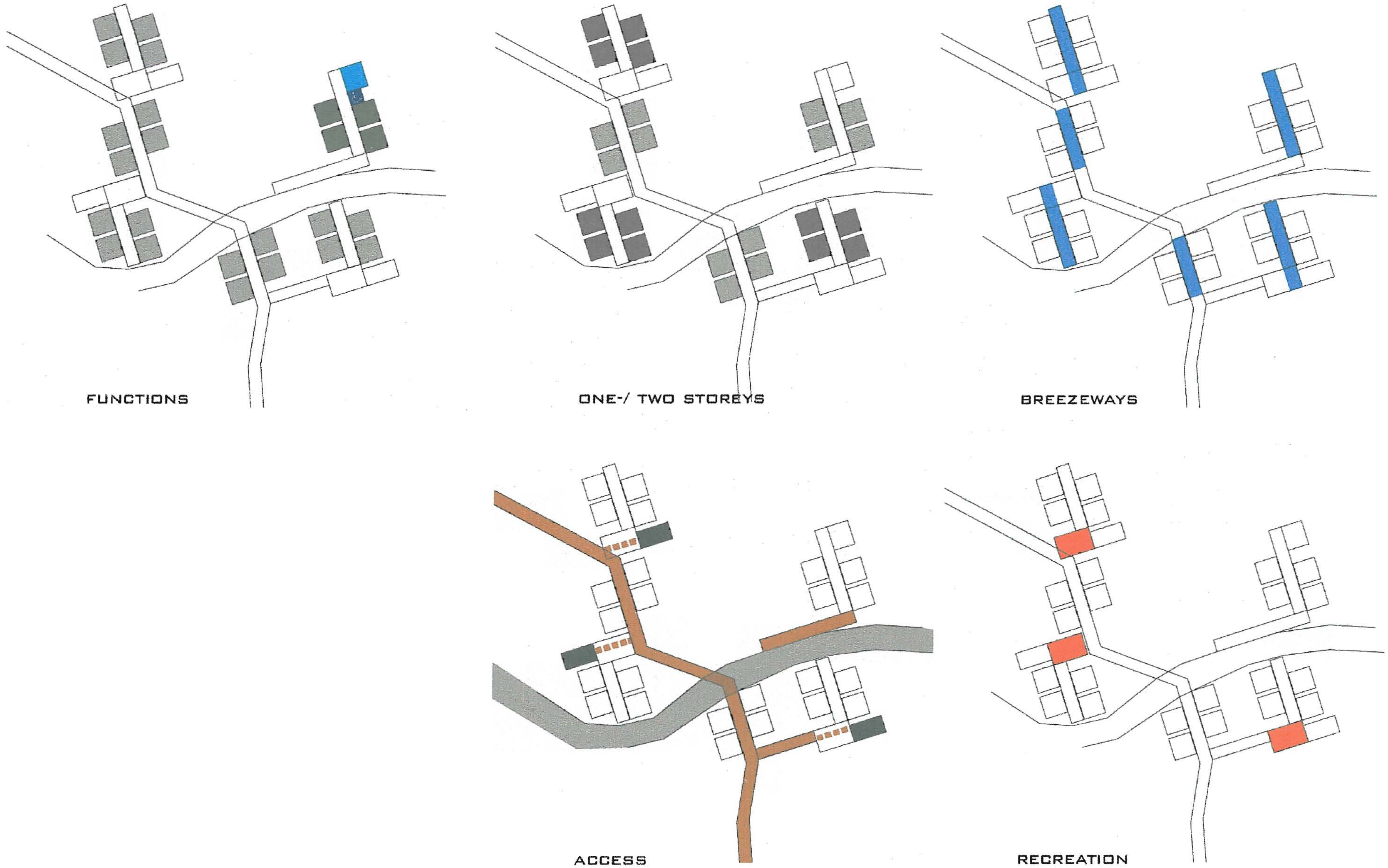


Fig.51 Schemes for Accommodation

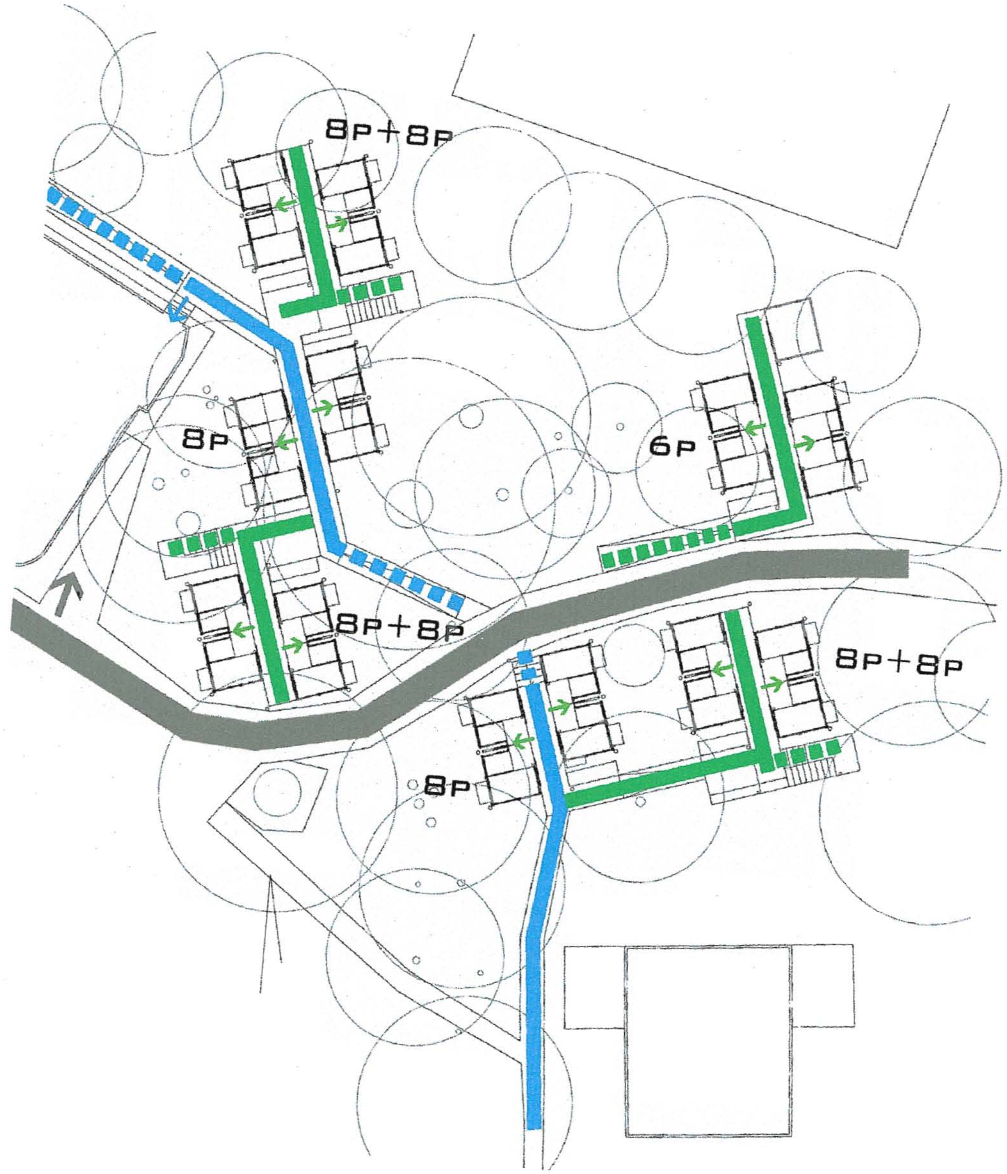


Fig.52 Circulation

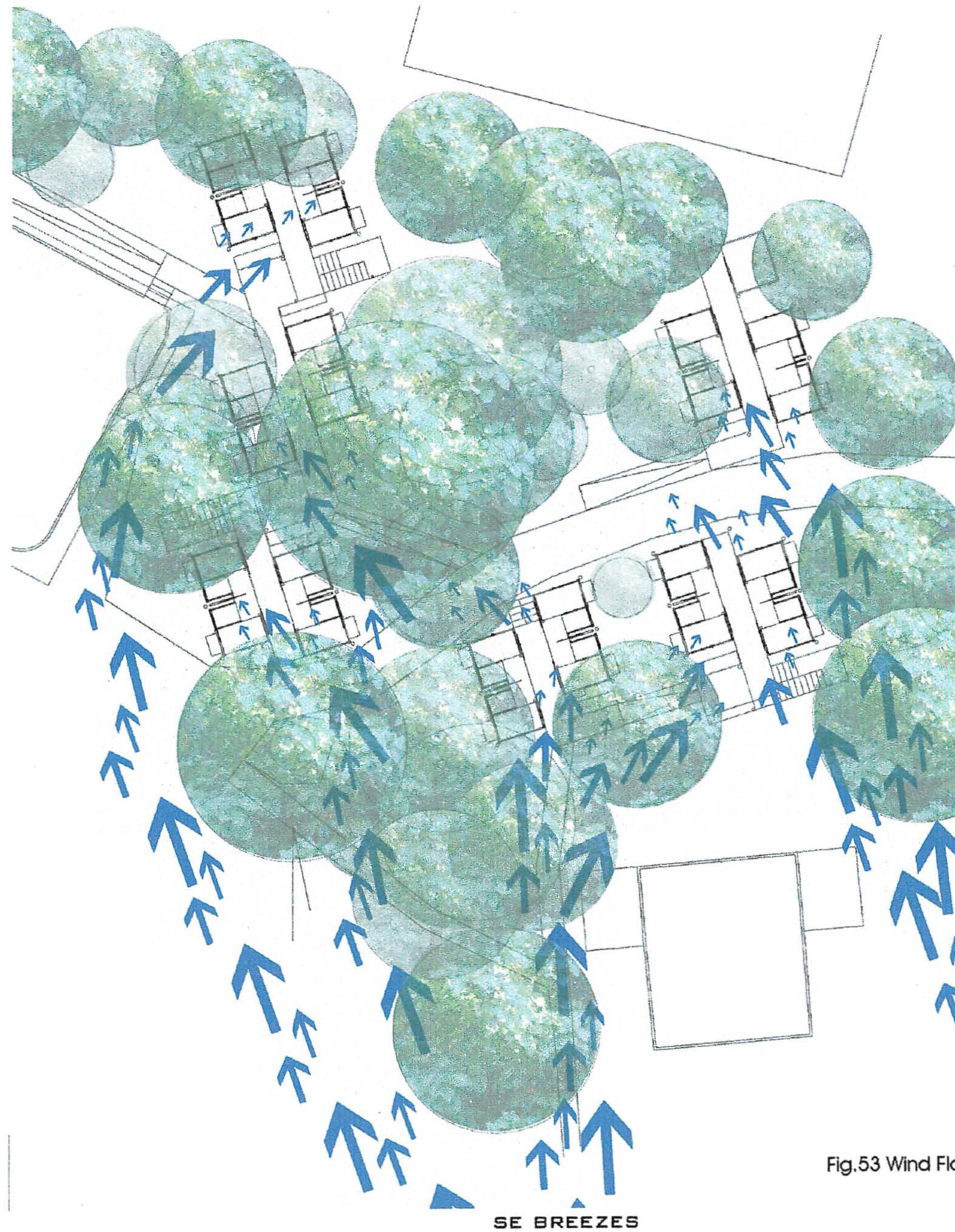


Fig.53 Wind Flow

3_2_3 Site Planning Laboratory

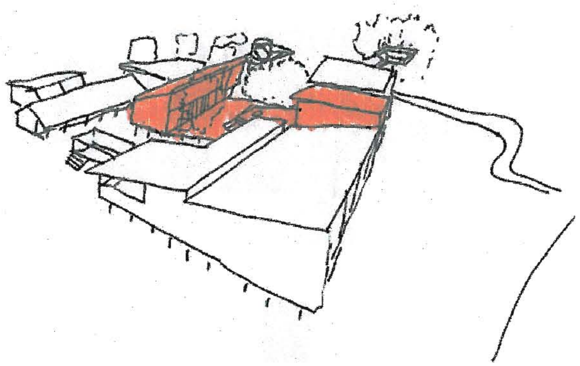


Fig.54 Sketch Laboratory

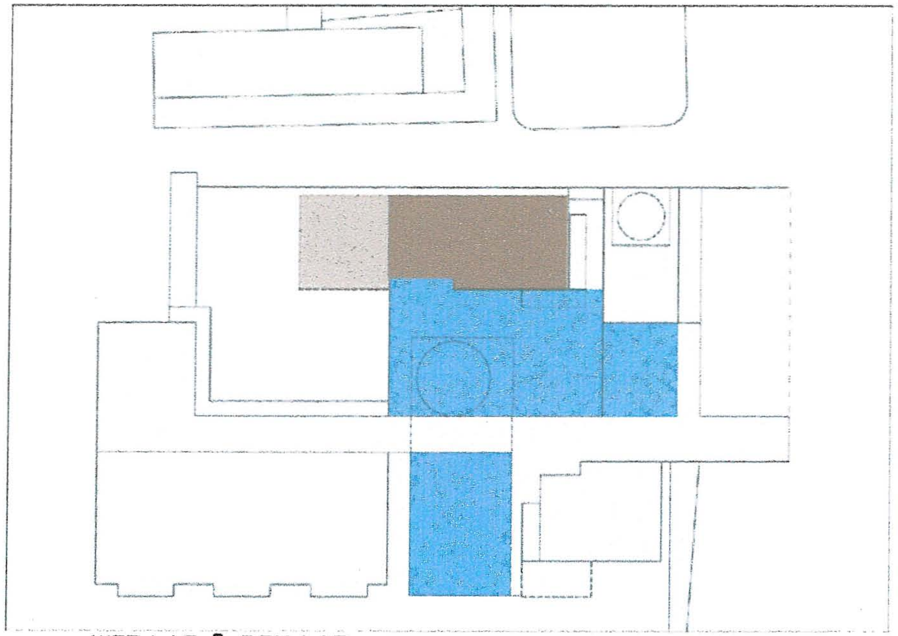
In contrast, the laboratory facilities are dispersed on two separate blocks. The position of both buildings is determined by the contextual constraints of existing trees and buildings and by footprint considerations. Oriented north/ north-east, the laboratory is located along the path, parallel to the existing buildings which will allow sun control on the northern facade and air-flow through the site. Additional facilities, such as a computer room and lab manager office, are accommodated in an elevated building that fills the void between the teaching facility and seminar building and which provides a covered wet laboratory underneath.

A central courtyard space is created to link the functional elements of the operational zone. Framed by the laboratory and a tall Pisonia tree on one side, and by the existing seminar building and the teaching facility on the other, the courtyard is divided into 'frontyard' and 'backyard'. The 'frontyard', designed as a garden with recreational facilities for common use, is the space near the entrance, between the teaching facility and the opposed kitchen building. An elevated platform in front of the laboratory defines the 'backyard' which comprises outdoor wet lab space reserved for professional use. Continuous circulation is provided by a walkway which runs along the platform edge and the seminar building, passes under the new elevated building and the verandah of the teaching facility and finishes in front of the kitchen building, where it connects to the path.

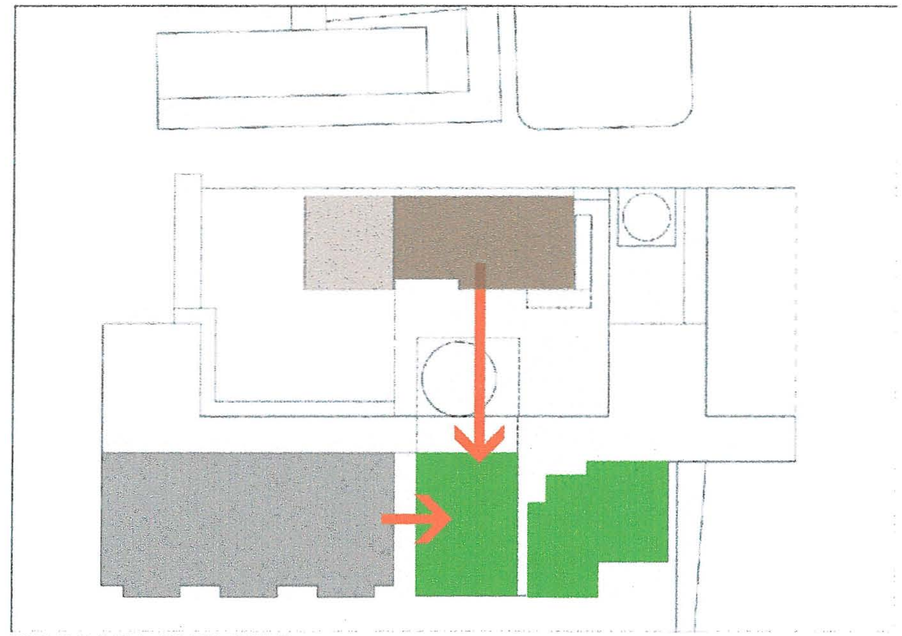
The displacement of the laboratory building generates a considerable space between the platform and the accommodation zone. The largely degraded area should be recovered through revegetation and replacement of the path with an elevated boardwalk. The rapidly growing vegetation on Heron Island and the territorial behaviour of the Mutton Birds will contribute to a fast recovery. This strategy does not exclude the area' s future use for building extensions.

The footprint of the laboratory facility is reduced in three different ways: firstly, the entire construction for building, platform and circulation is elevated so that vegetation and wildlife can pass underneath; secondly, the buildings are located on previous building footprints and thirdly, the area to accommodate the old laboratory becomes available and converts back into a nature dominated territory.

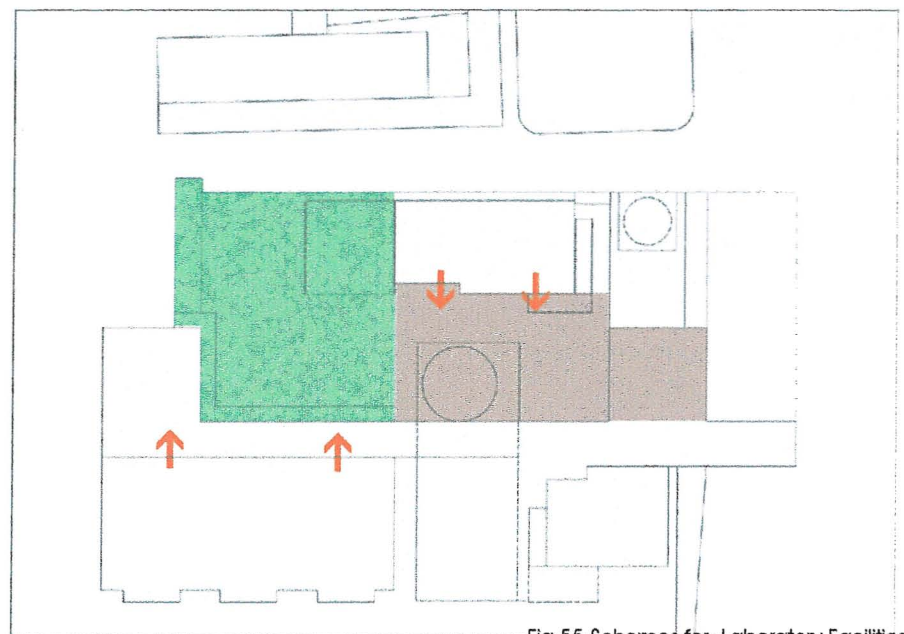
Please see Fig.55-58.



WET LAB & DRY LAB

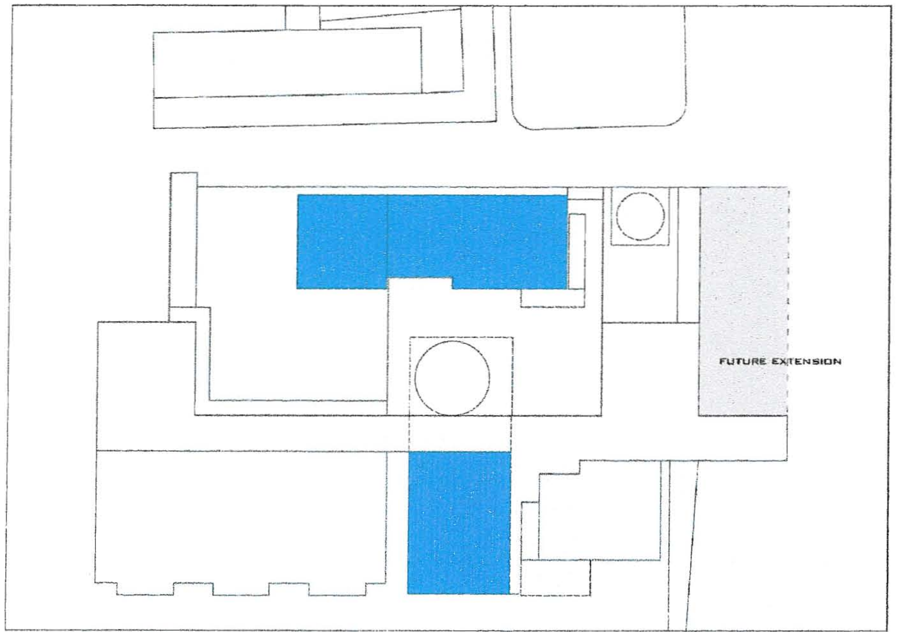


COMMUNAL FACILITIES

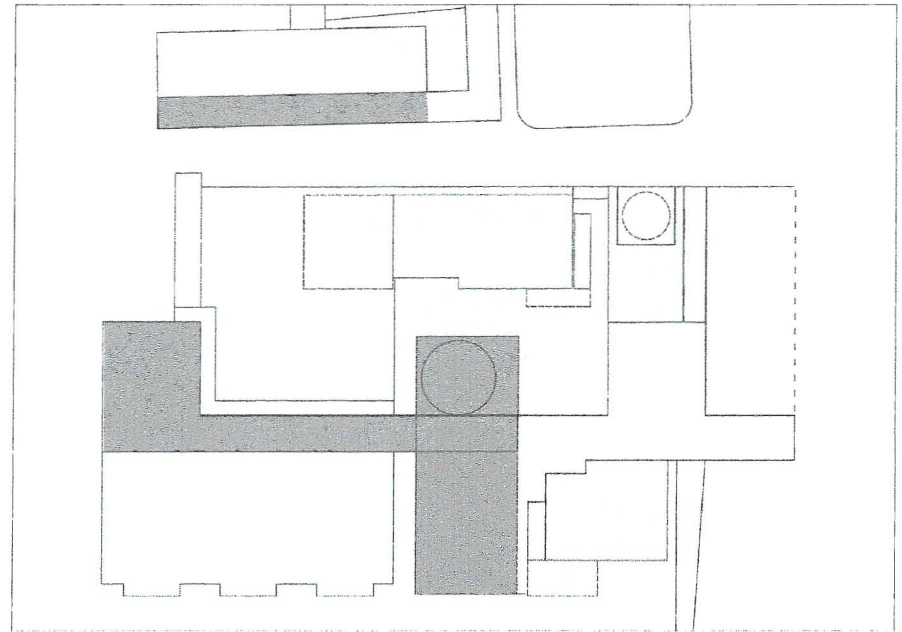


FRONTYARD & BACKYARD

Fig.55 Schemes for Laboratory Facilities



DISTRIBUTION


COVERED OUTDOORS

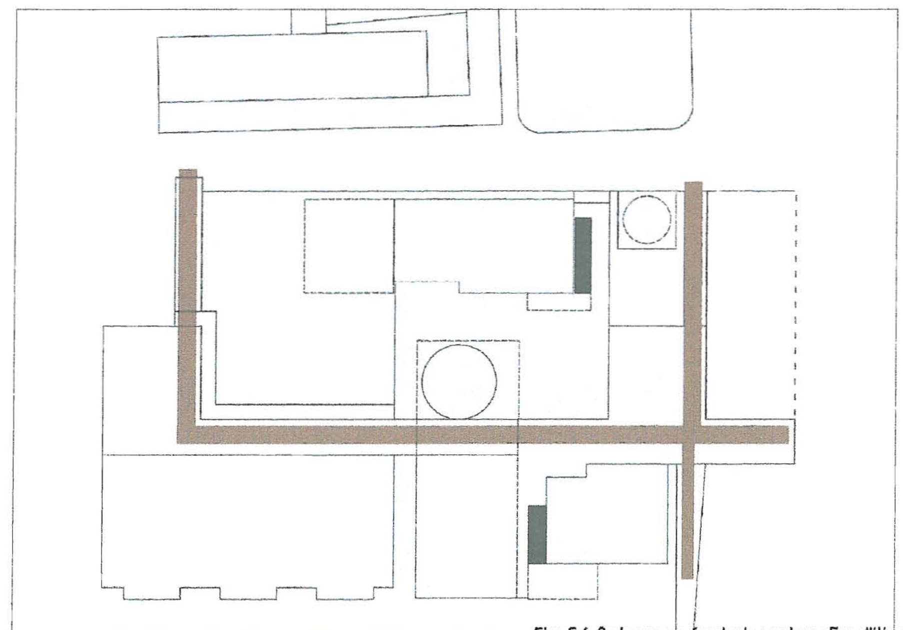
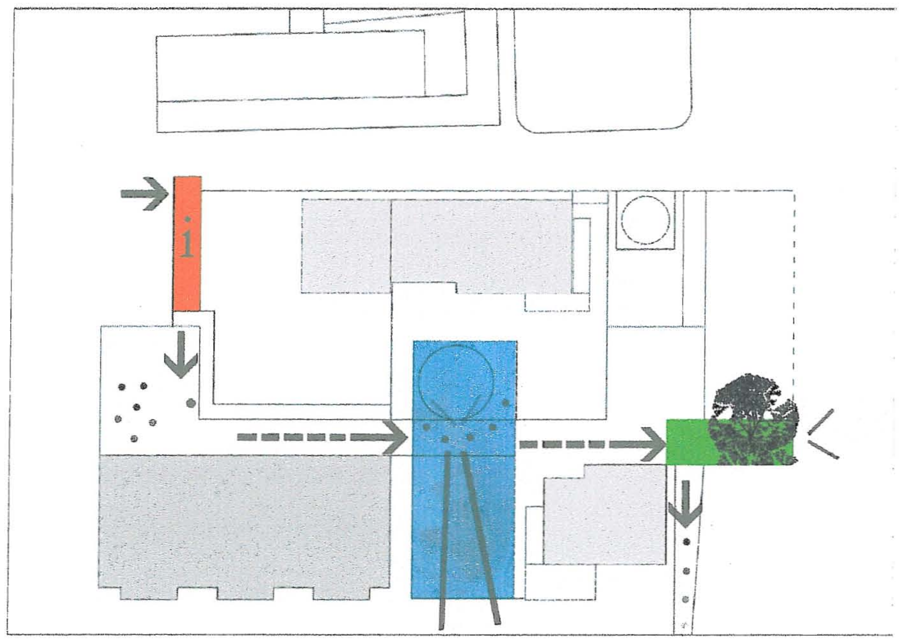
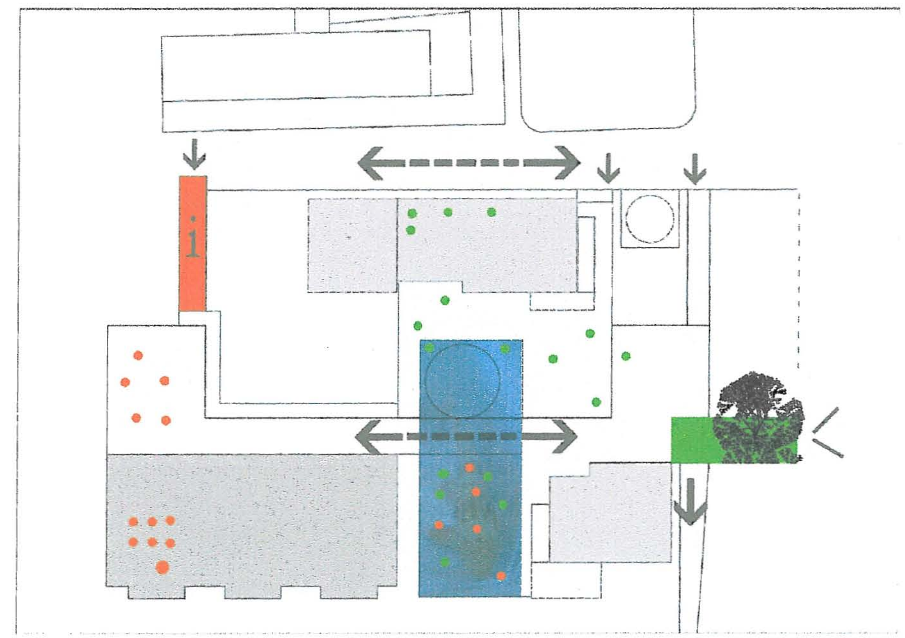

ACCESS

Fig.56 Schemes for Laboratory Facilities



VISITOR CIRCULATION



STUDENT & RESEARCHER CIRCULATION

Fig.57 Circulation

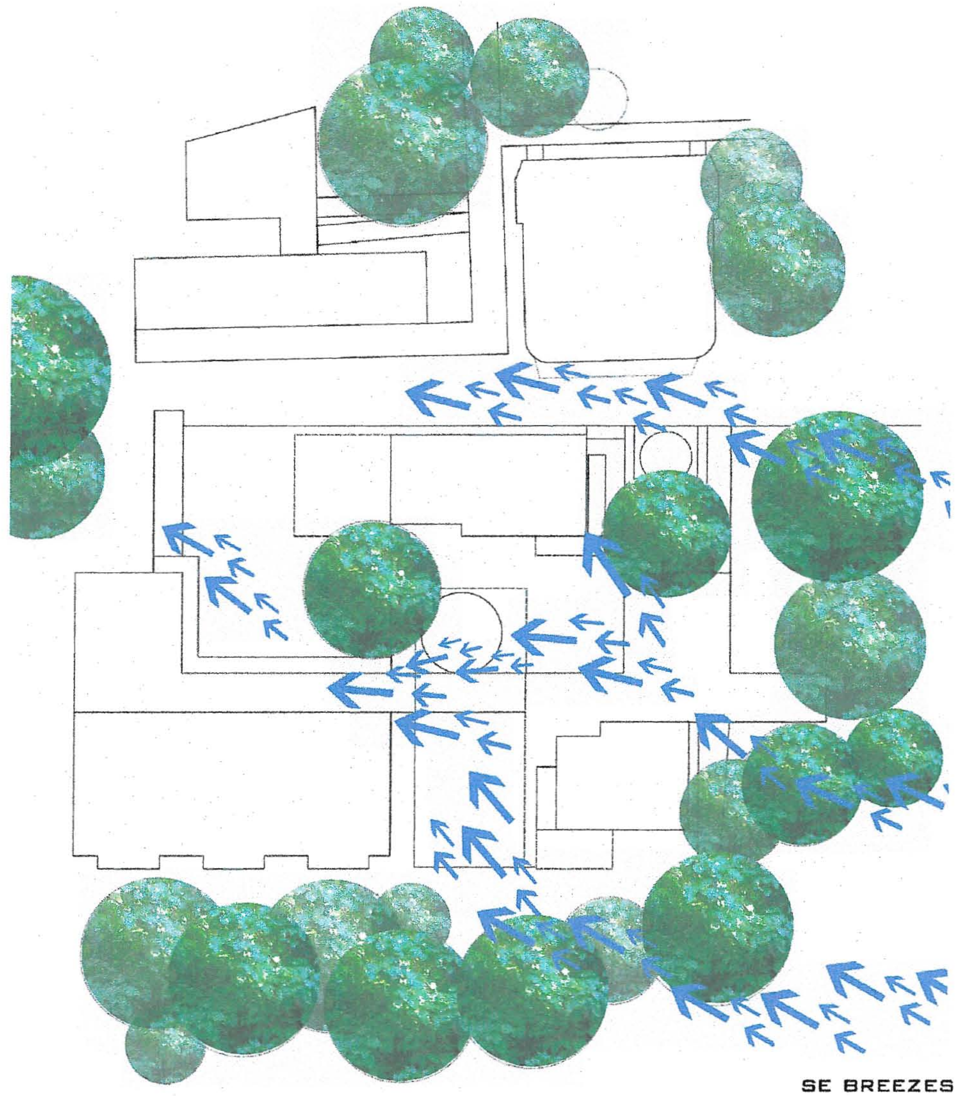


Fig.58 Wind Flow

3_3 Accommodation Facility Design

3_3_1 Design Response

Fig.59 Noddy Nest between Pisonia Branches

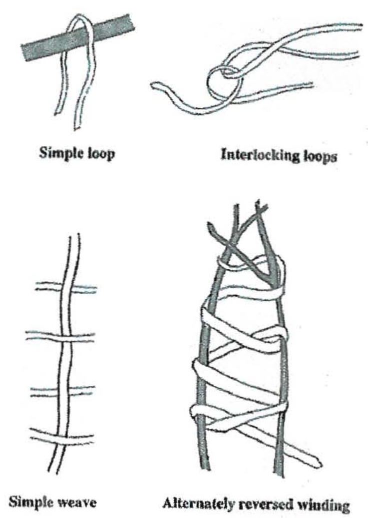


Fig.60 Nest Construction Methods

Lodged among the Pisonia trees the accommodations conjures up associations with nests that provide shelter to sleep right next to birds and branches. Connected by an elevated walkway, these nests line the path towards the beach. The walk comprises various sequences of covered deck spaces, narrow breezeway areas, ramps and stairs. The tactile senses are developed through the light that shines through the leaves and fills the space with various colours of green, the smell of the birds and the feeling of the timber boardwalk decking on bare feet.

The adjacent buildings are designed as elevated pavilions with a primary structure in steel, holding two timber 'nests' separated by a central circulation and covered by a light parasol roof. The insertions consist of bunk modules in a one- or two-storey composition. One module comprises two bunk spaces which will result in a paired module accommodating 4 people and a double-storey paired module offering space for 8 people. Thus, a two-storey pavilion can accommodate 16 people, a one-storey pavilion only 8. The modules can be subdivided by a system of sliding doors which will allow various privacy levels and the possibility of connecting the space in all four modules on one storey.

The bunk overlay in a crossed manner relates to nest construction methods, such as weaving and interlocking.[2] To minimize the space for human occupation, the design of the compartments is similar to Japanese capsule accommodation[3] based on the size of a single bed. With regard to the constraints of prefabrication and standard

[2] Mike Hansell, Bird Nests and Construction Behaviour (Cambridge: Cambridge University Press, 2000), pp. 62-95
[3] Axel Sowa, Japanese Hotel Capsules, L'architecture d'aujourd'hui, Micro-architectures 328 (June 2000), pp.86-87

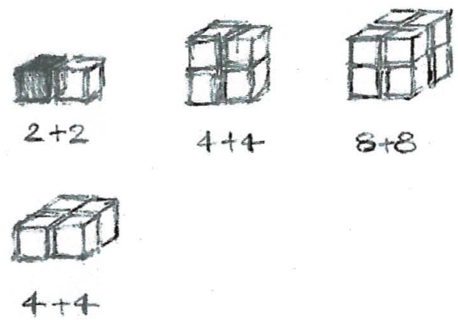


Fig.61 Modular Composition

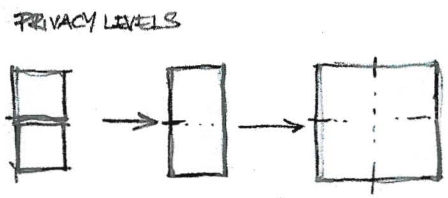


Fig.62 Grouping Scheme

panel sizes, all compartments have an area of 1.20 x 2.40m and a height of about 1.00m. They are designed as private retreats with each bed having its own window at the top end. This opening is a tool for environmental interaction allowing each occupant to manipulate it for light/ shading, ventilation/ enclosure or privacy/ exposure. The window is composed of a number of elements arranging for different conditions:

_ fixed panels provide shading and ensure that the window can be kept open when it rains;

_ moveable shutters provide cyclone protection and privacy and direct breezes into the building;

_ sliding elements of transparent polycarbonate glazing ensure enclosure during cooler weather;

_ and sliding insect screens protect against animals.

Additional openings with horizontal and vertical blades, located at the side of each bed, augment cross-ventilation and let daylight in.

The building envelope is designed to maximize openness. Cooling is primarily achieved through natural ventilation and supplemented by the effect of fans. Measurements of the air-flow under the trees have shown that mechanical ventilation is necessary during calm periods. Air-conditioning is not efficient, because the dormitories do not provide for permanent occupation. The following strategies for natural ventilation are applied:

> The pavilions are split into two slim cubes detached by a central breezeway.[4] Shifting the cubes slightly generates not only communal outdoor space, but also helps to capture the prevailing breezes from the southeast. Elevated above ground level, the buildings are exposed to the breezes chilled by the surrounding vegetation.

[4] Richard Hyde, Climate Responsive Design (London: E & FN Spon, 2000), p.211

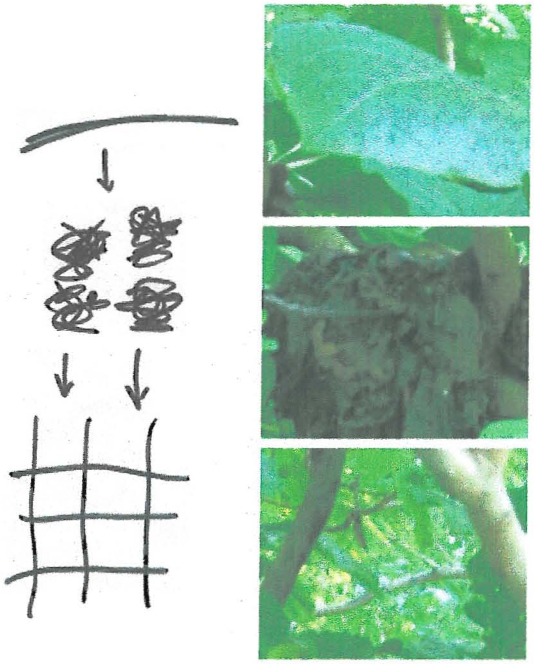


Fig.63 Concept of the Nest

> The section shows horizontal and vertical connection spaces throughout the building. The vertical interconnection of the modules expresses the design idea of interlocking as well as allowing continuous air-flow between the two levels. Internal obstructions are avoided by using sliding and perforated enclosure and partition elements. Openings on all sides of the building promote cross ventilation.

Solar radiation on the accommodation is largely reduced by the shade of surrounding trees. The roof and eastern and western facades are most likely to be affected by solar heat gain and therefore insulated. Openings are screened and a second roof layer protects the whole building against the sun and rain.

3_3_2 Construction and Materials

The dormitories are designed as demountable pavilions of prefinished steel frames which respond to the requirements of a lightweight and low mass structure. The following describes the main reasons for the selection of steel.

Firstly, steel structures offer the best performance for deconstructability, re-use and even 100% recyclability. They can be easily assembled and demounted with minimum impact on the site. Construction periods and probably also the future existence of the research station on Heron Island will be limited. For that reason this design meets the characteristics of a rather temporary building.[5]

Secondly, steel is particularly resistant. Material loads to erect a cyclone proof structure can be avoided as steel can be used in relatively small cross-sections.[6]

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[5] Robert Kronenburg, The image and identitiy of portable architecture, Houses in Motion (Chichester: Wiley-Academy, 1995), p.133

[6] Environ, Reuse, rebuild, recycle (September 2002), pp.8-9

Thirdly, steel can be prefinished off-site so that previously welded connections just need to be bolted together and the assembly process can even be carried out by unprofessional labour.

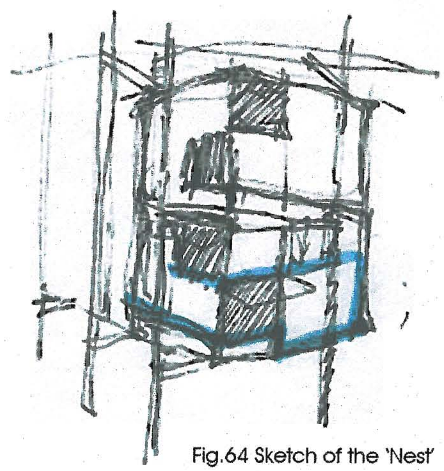

Fig.64 Sketch of the 'Nest'

Inspired by the structure of birds nests, the pavilion is a composition of a simple braced steel frame, plywood panel lining and a flying roof layer.
CHS columns and C-profile joists form the primary structure which acts as a protective shield against outer influences such as cyclones and dropping branches. The external studs are designed so that they look as continuous through the full height of the building and relate to the verticality of the surrounding trees. The primary structure is founded on screw-piles which raise the building above the vegetated Mutton Bird habitat. Installed with the help of small bobcats, screw-piles have the advantage that they can be fully removed from the soil afterwards. This excludes permanent construction remains on the island and demonstrates that screw-piles have less environmental impact than conventional concrete foundations. The steel stairs are prefabricated with hardwood flooring that is generally used for circulation areas. The boardwalk decking will be made of recycled timber from the demolished buildings.

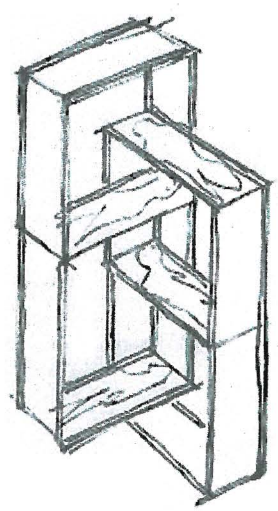

Fig.65 Loop Structure

The module structure is based on two pairs of steel rings that are suspended from or set into the primary steel frame referring to different kinds of nest attachments. Clad by standard sized plywood panels and sandwich elements, the rings interlock to form a bunk module.

A waterproof PVC membrane held by the primary steel structure covers the arrangement like a leaf stuck to its twig and protects it from rain. The parasol roof allows maximum ventilation in the roof and its reflective character prevents heat loads on the pavilion. Washed by rain, the smooth surface of the membrane is easily cleaned of bird droppings and leaves. The elastic qualities of the membrane could be useful to handle dropped tree material.

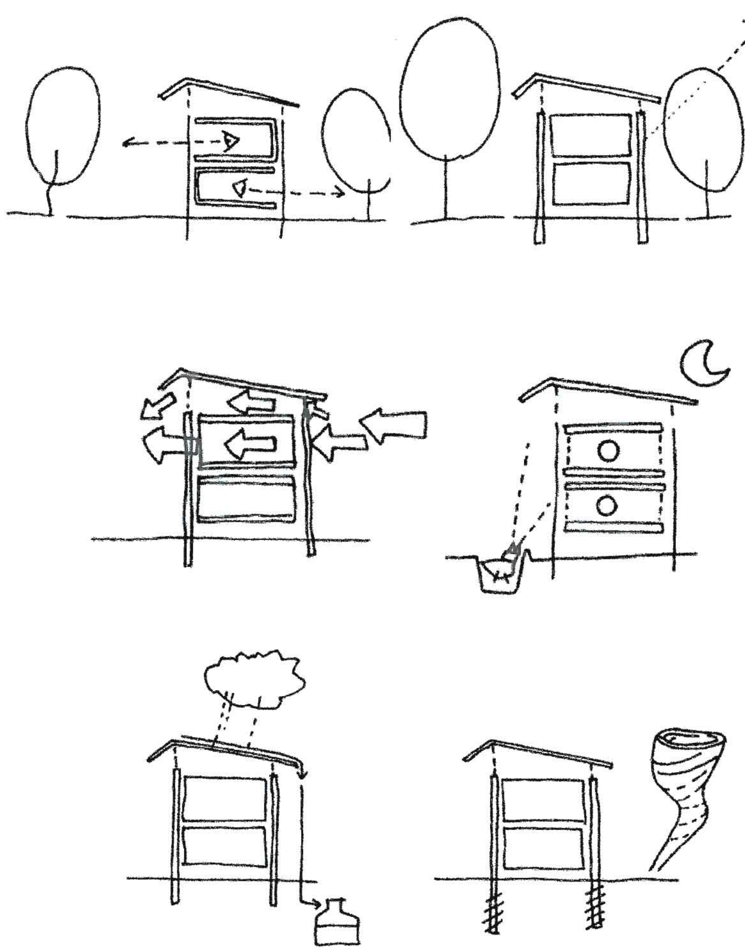

Fig.66 Schemes Accommodation

3_3_3 Environmental Performance

Rainwater collection from the membrane roof into small tanks under the building is an efficient strategy for this site, especially because the drainage prevents water from falling uncontrolled on the ground and destroying Mutton Bird burrows. Gutters with leaf guard systems and filter devices reduce water contamination. Solar energy collectors are not installed, because tree shading diminishes their productivity.
Lighting is reduced to the use of intermittent, low pressure sodium light outdoors and uniform, fluorescent fittings inside the pavilions.

Providing basic human shelter and standard comfort levels, the dormitories are designed to engage with their natural environment harmoniously, which implies minimum impact. Derived from the tropical sleep out space, the openable envelope design promotes interaction between in- and outdoors and contributes to creating the spatial experience of the 'insideout'.[7] The emotional tension caused by the simultaneous occurrence of shelter and exposure is used to 'create a frame of attention'.[8] The architecture encourages its users to discover the habitat shared with the surrounding flora and fauna. Interior space is turned into forest as sills extend out and panels open up. The occupant situated in the 'between' can be observer and participant at the same time. However, when Mutton Bird chicks start moaning as soon as it gets dark, it will make no difference whether the occupant is in- or outside.

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[7] Haig Beck and Jackie Cooper, Insideout, UME 15, 2002, pp.8-9
[8] Colin St John Wilson, Architectural Reflections (Oxford: Butterworth Architecture, 1992), p.17

The overwhelming vocalizations of the 'moaning birds'[9] will clearly remind occupants that Heron Island is a bird territory.

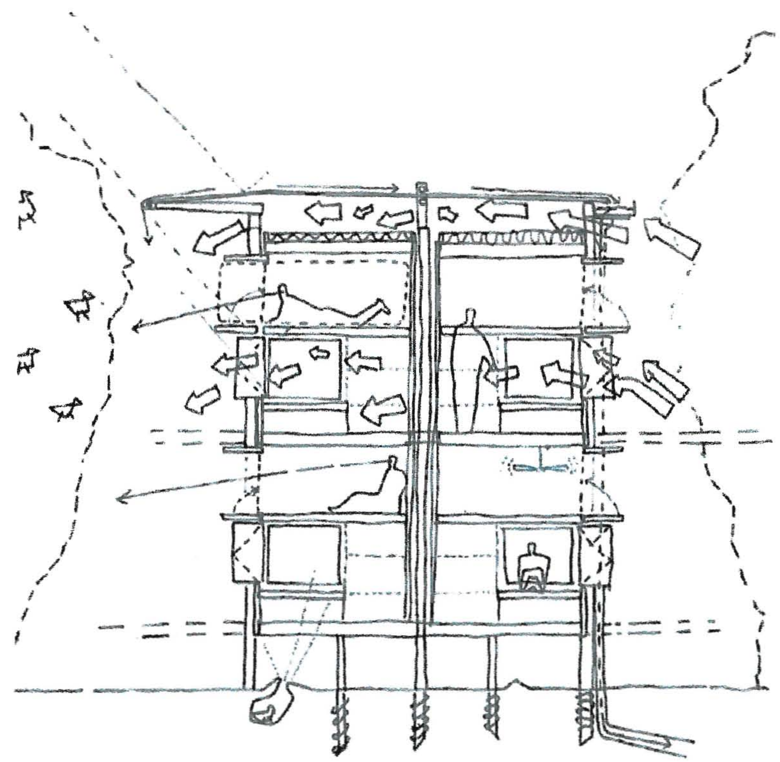


Fig.67 Performance

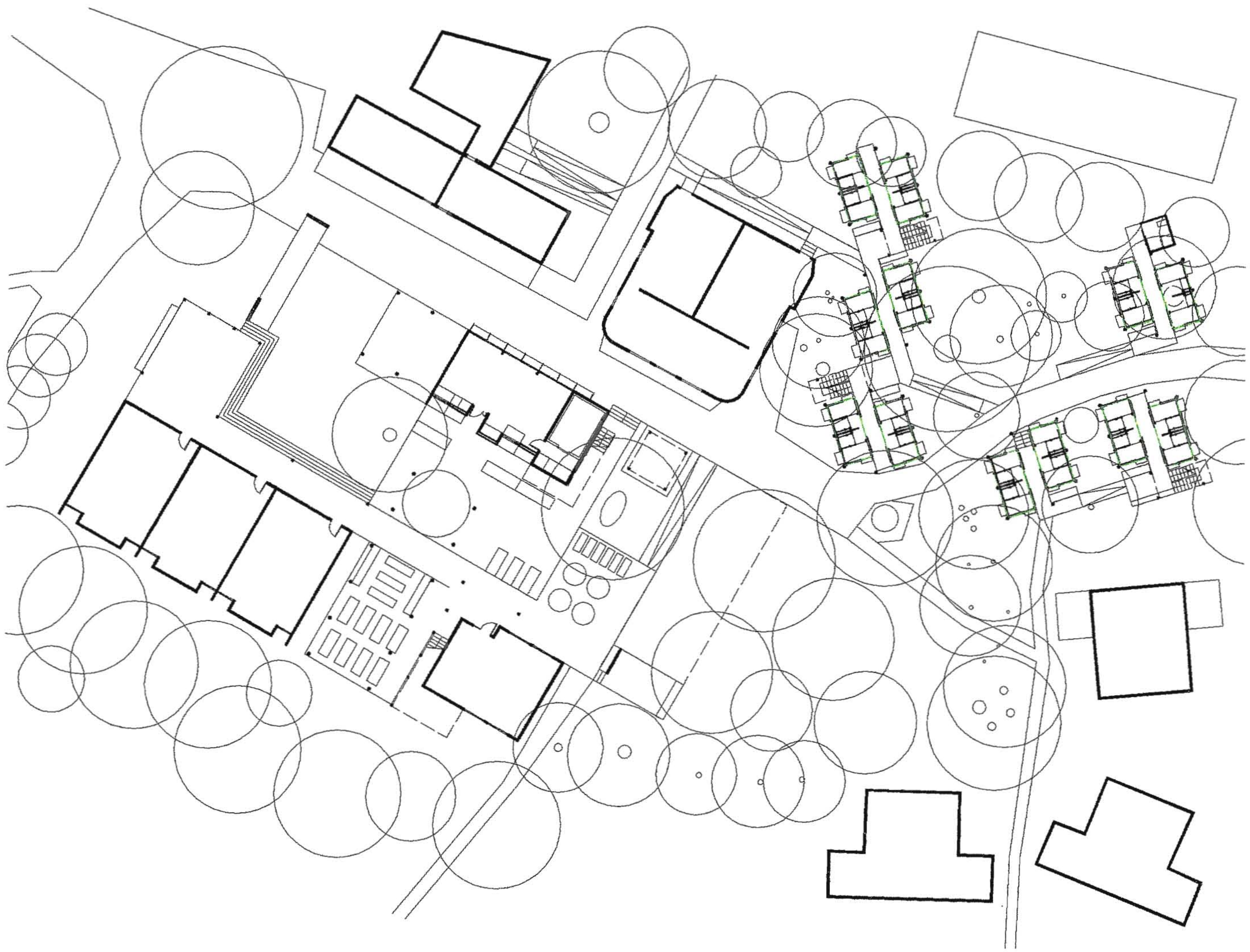
3_3_4 Project Drawings

Please see Fig. 68-84 and the summary sheet in Tab.5.

[9] http://midway.fws.gov/wildlife/wtsh.html, 09.04.2003

0.1_ accommodation and laboratory facilities @ HIRS _ general plan _ scale 1:500

Fig.68



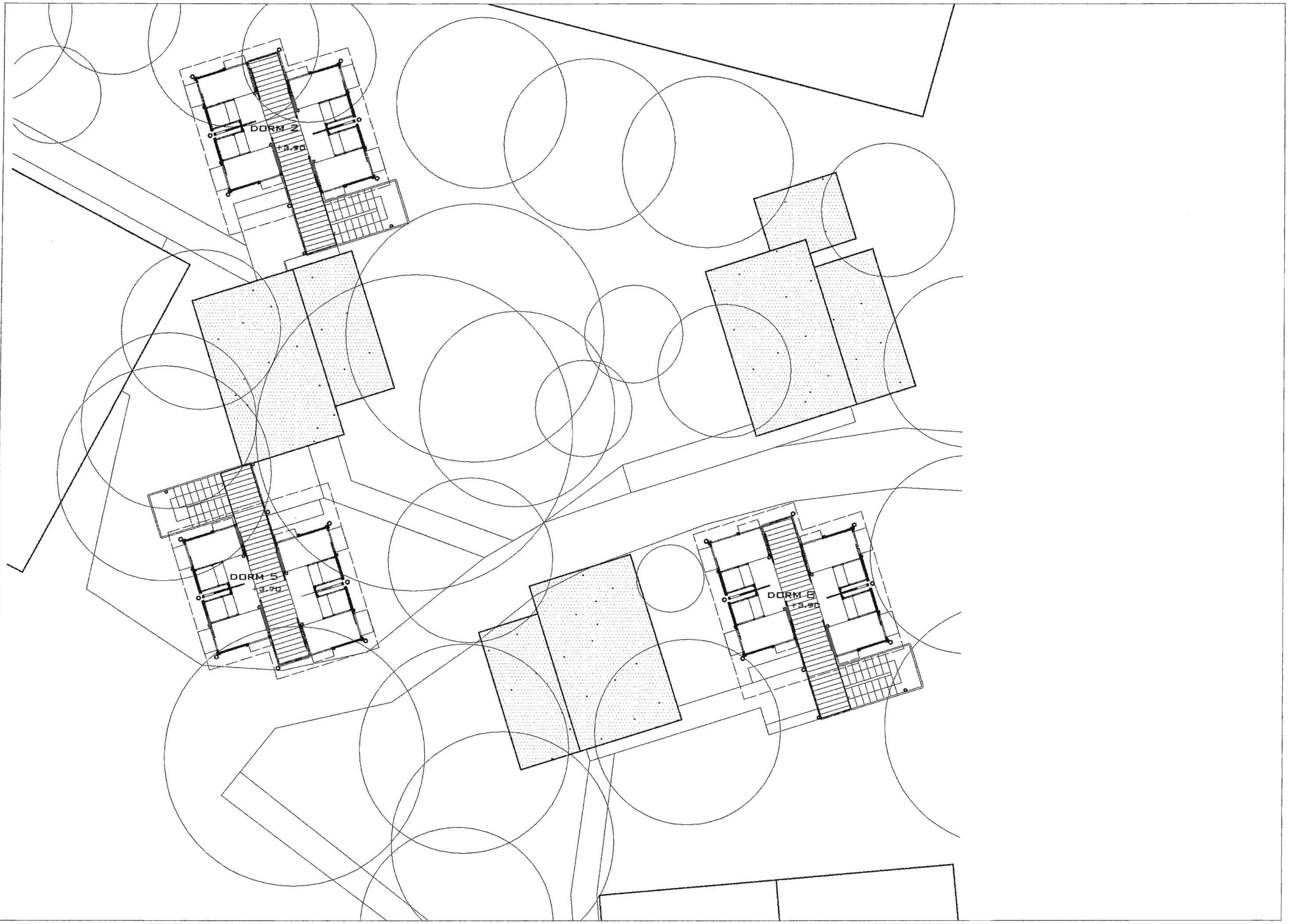
1.1_ accommodation facilities @ HIRS _ general plan _ scale 1:500

Fig.69

M Phil (by design)_ The University of Queensland_ Katrin Wichelhaus August 2003

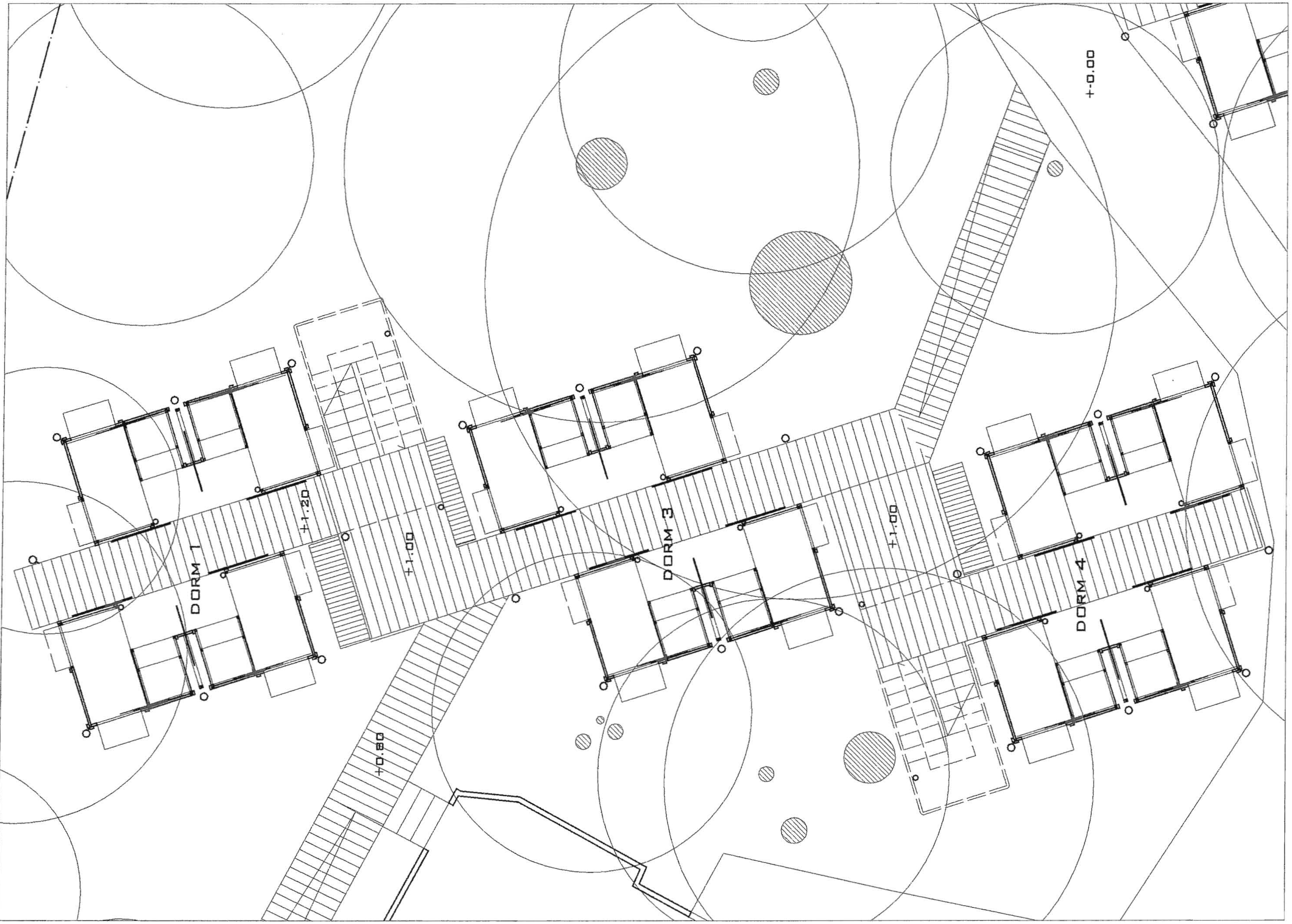
1.2_ accommodation facilities @ HIRS _ plan groundlevel _ scale 1:200

Fig.70



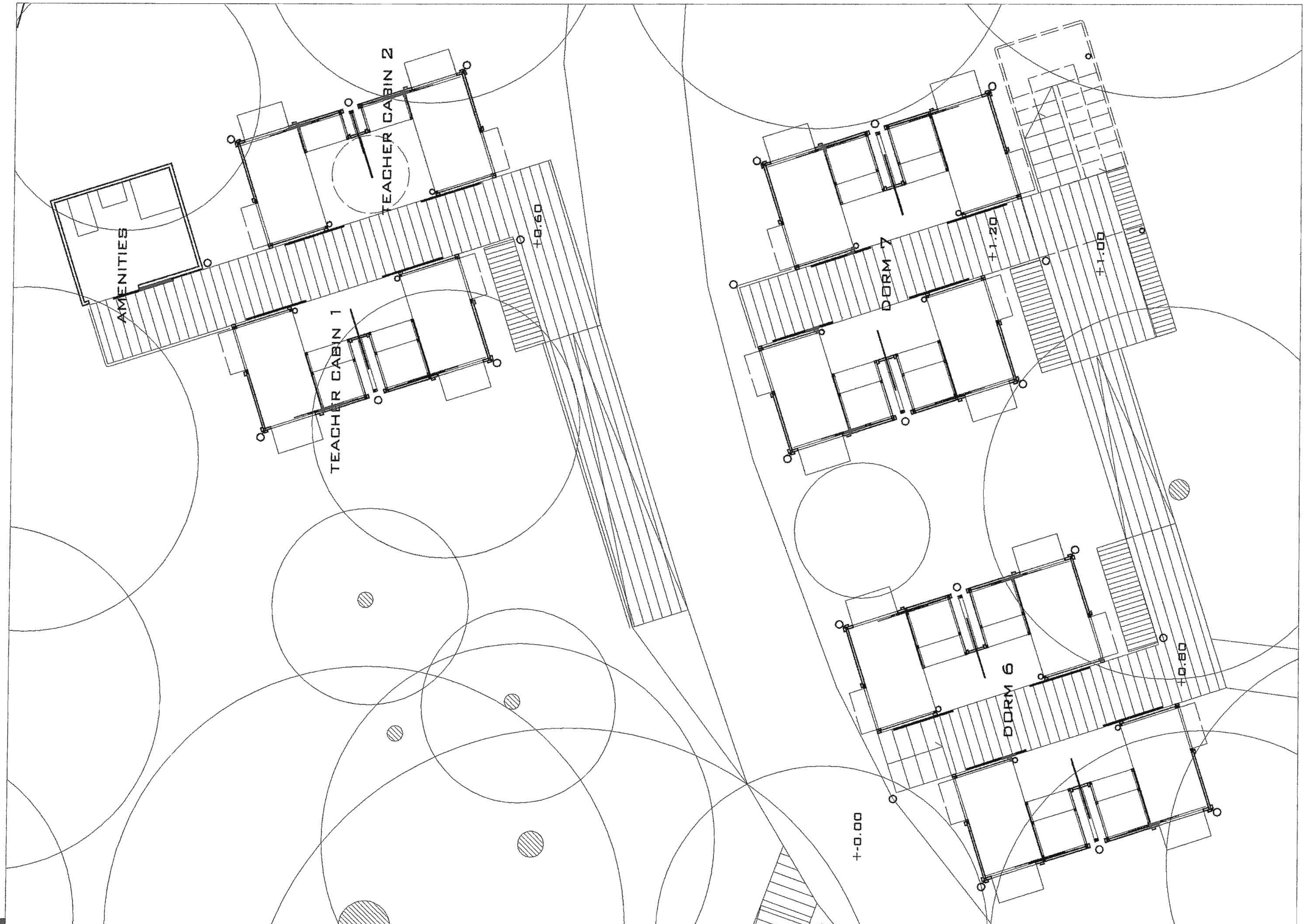
1.3_ accommodation facilities @ HIRS _ plan upper level _ scale 1:200

Fig.71



1.4_ accommodation facilities @ HIRS _ plan A groundlevel _ scale 1:100

Fig.72



1.5_ accommodation facilities @ HiRS _ plan B groundlevel _scale 1:100

Fig.73

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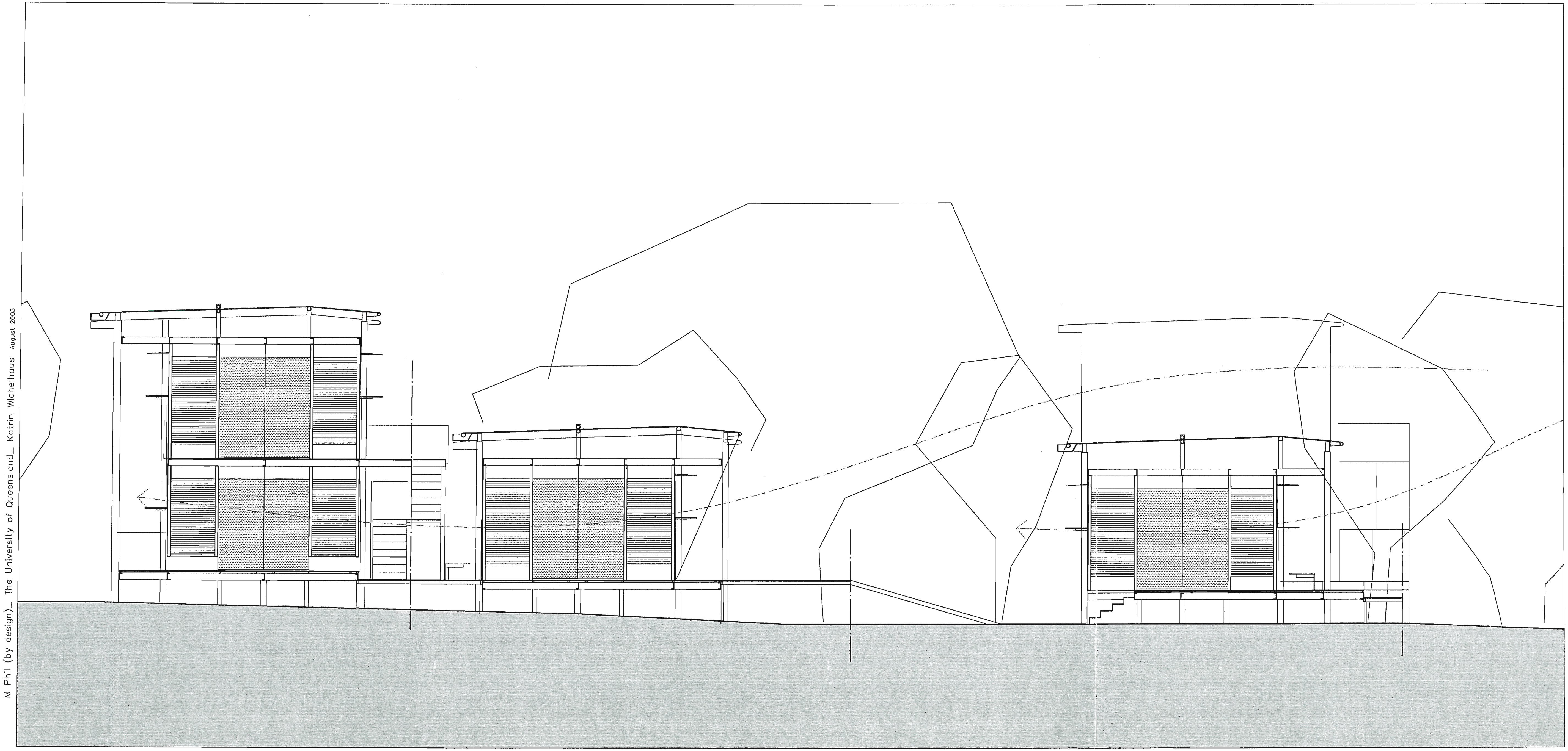
1.6_ accommodation facilities @ HIRS _section A–A _ scale 1:100

Fig.74

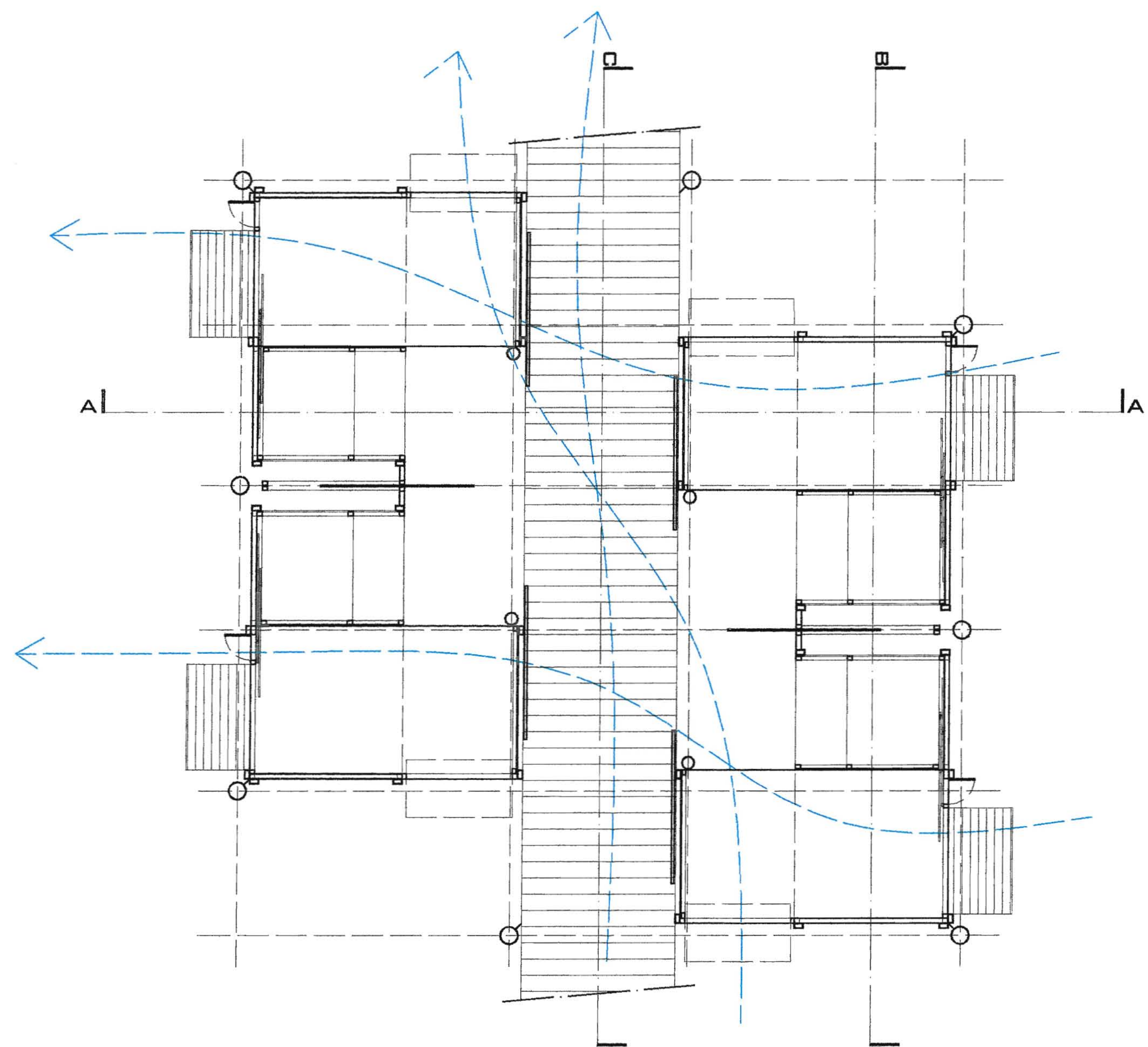


1.7_ accommodation facilities @ HIRS _ section B–B _ scale 1:100

Fig.75

1.8_ accommodation facilities @ HIRS_ section C-C _ scale 1:100

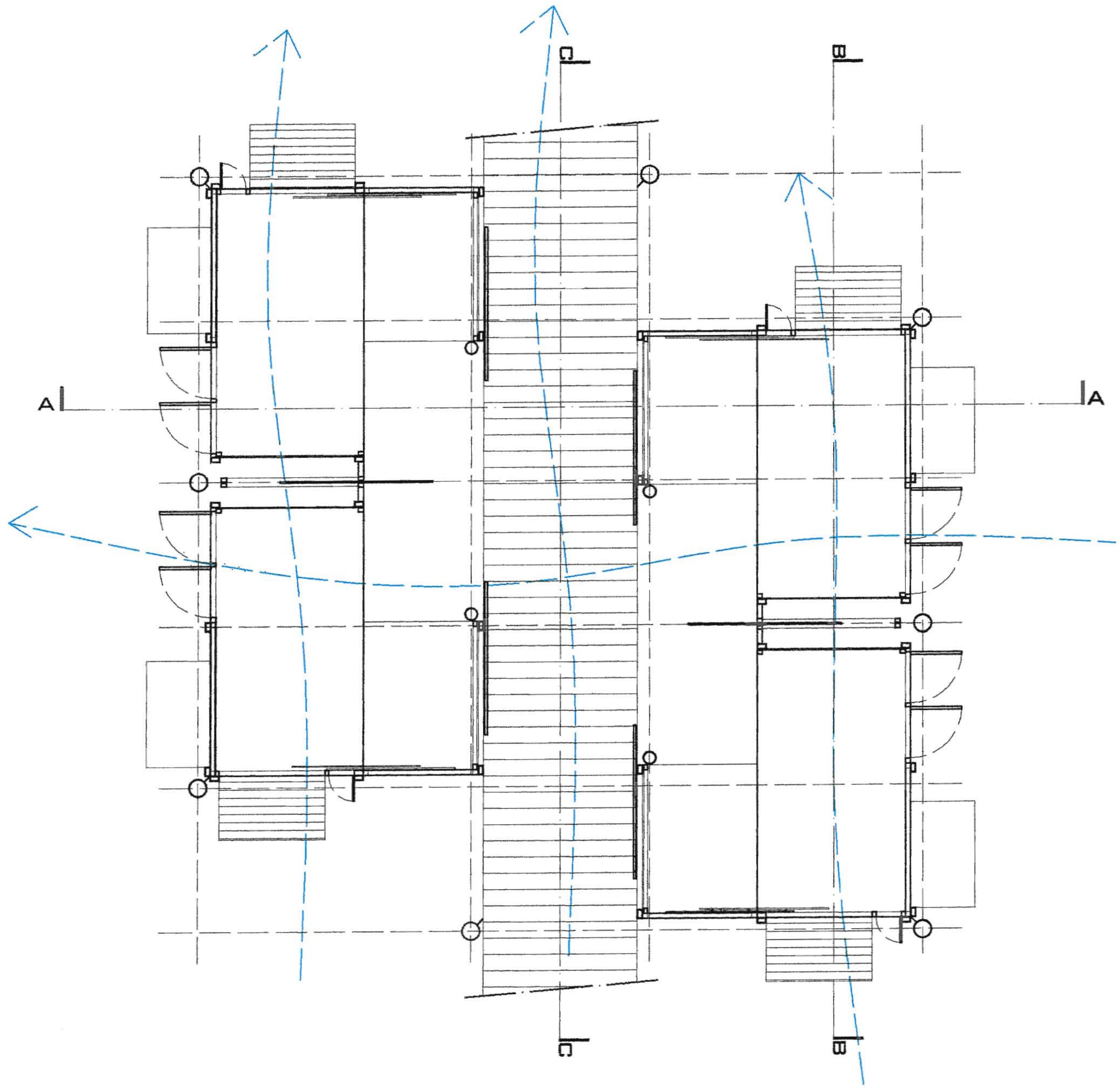
Fig.76



1.9_ accommodation facilities @ HIRS _ standard plan +0.80 _ scale 1:50

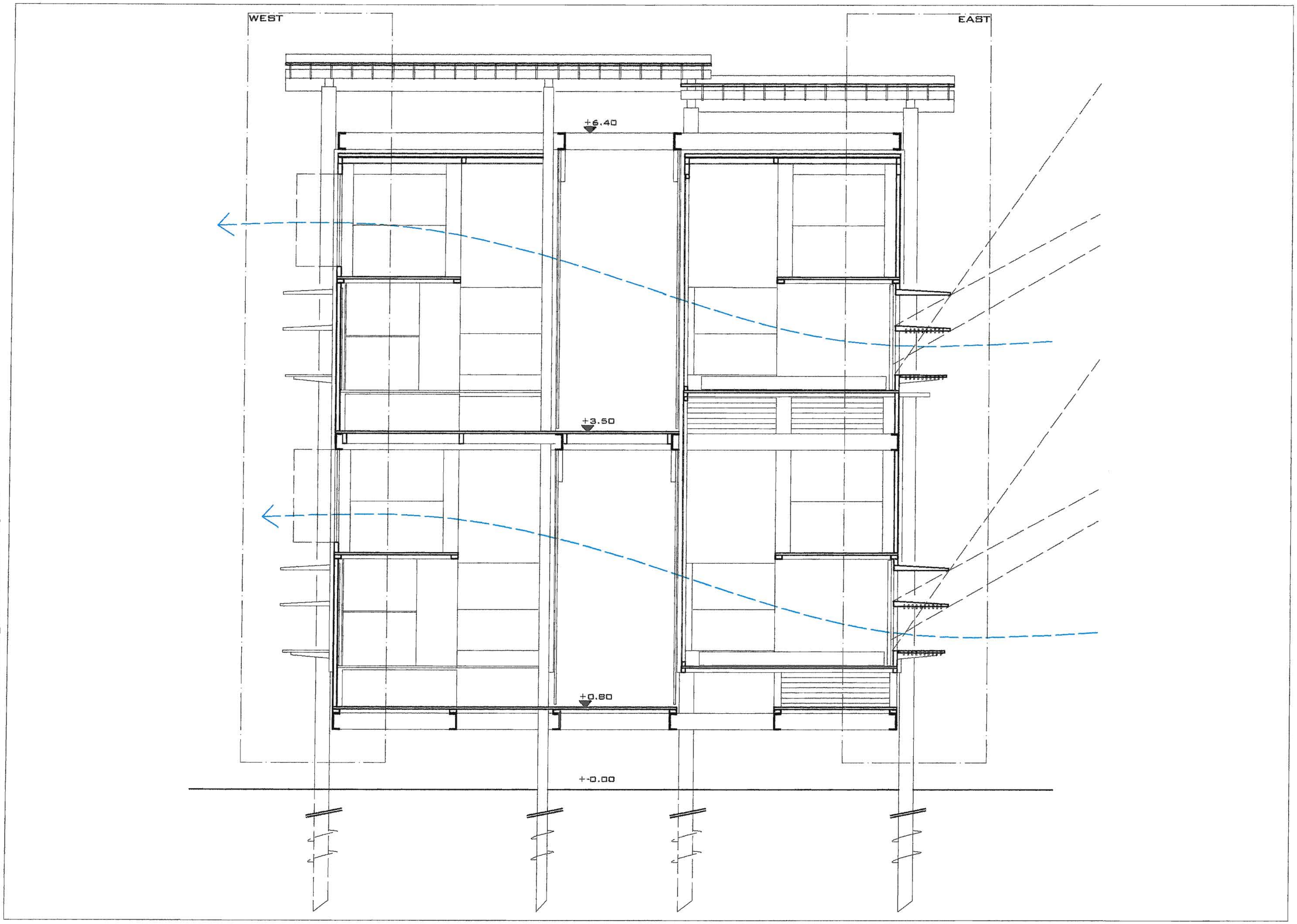
Fig.77

M Phil (by design)_ The University of Queensland_ Katrin Wichelhaus August 2003



1.10_ accommodation facilities @ HIRS _ standard plan +2.50 _ scale 1:50

Fig.78



1.11_ accommodation facilities @ HIRS _ standard section A-A _ scale 1:50

Fig.79

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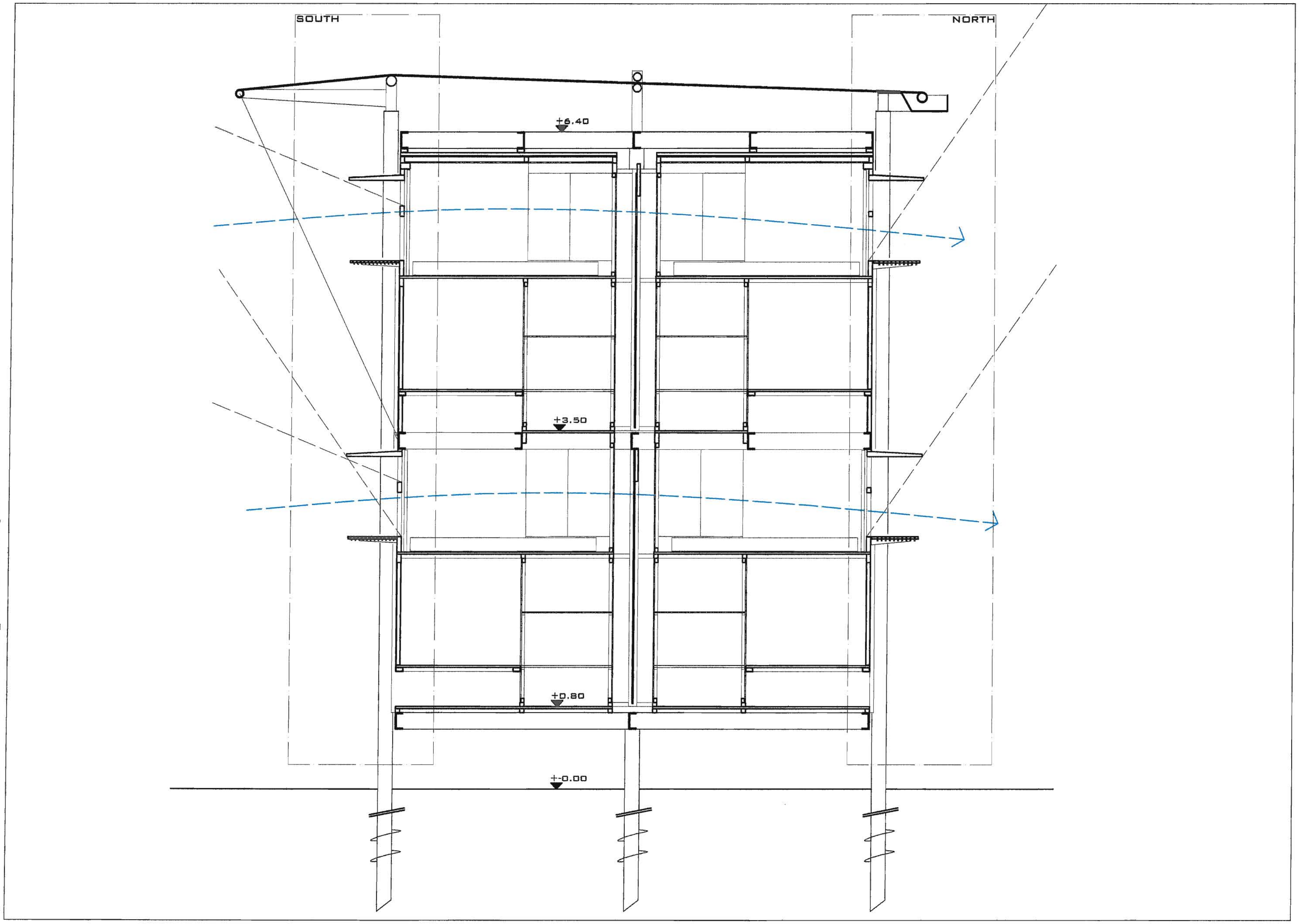
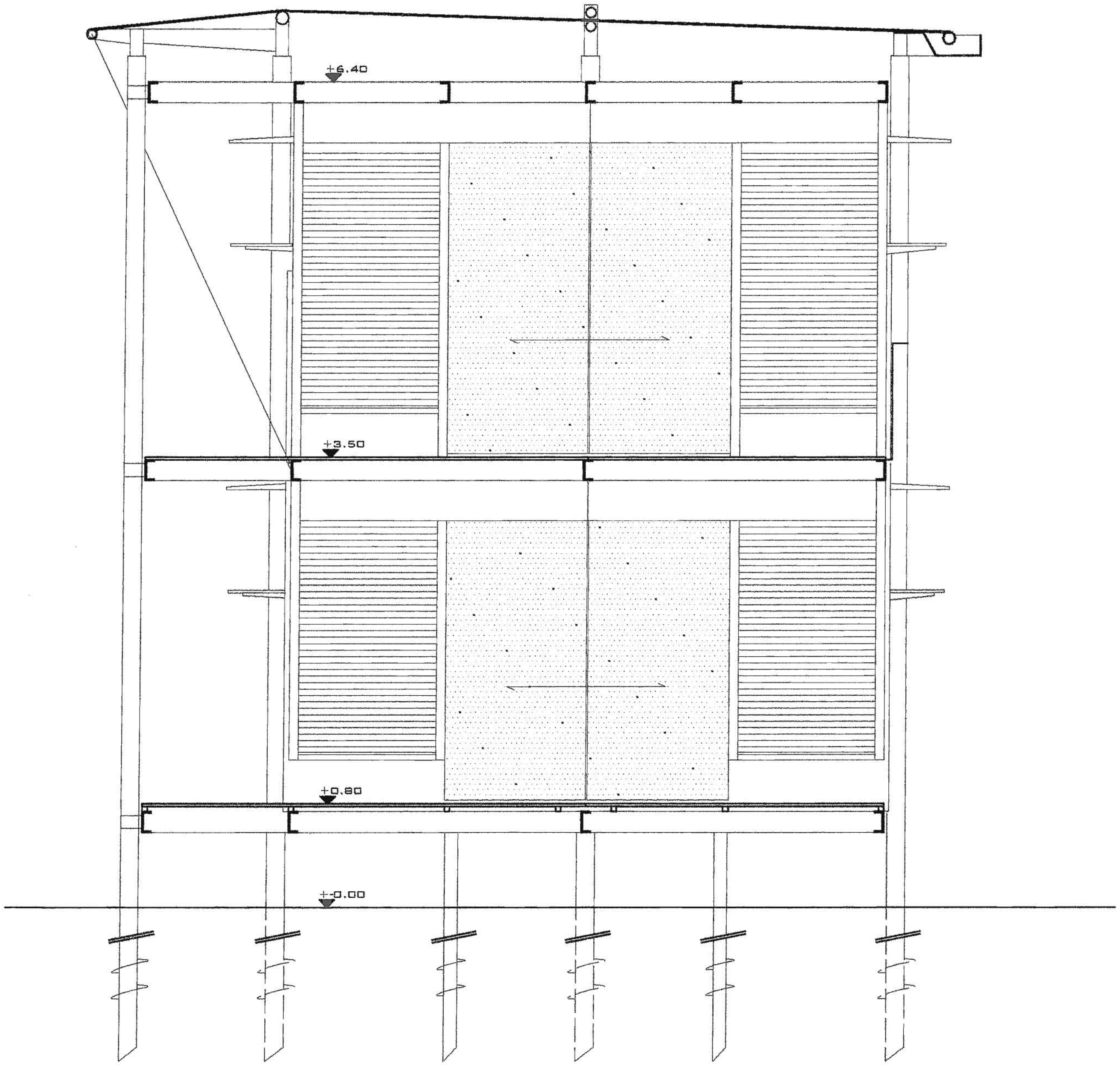


1.12_ accommodation facilities @ HIRS _ standard section B-B _scale 1:50

Fig.80

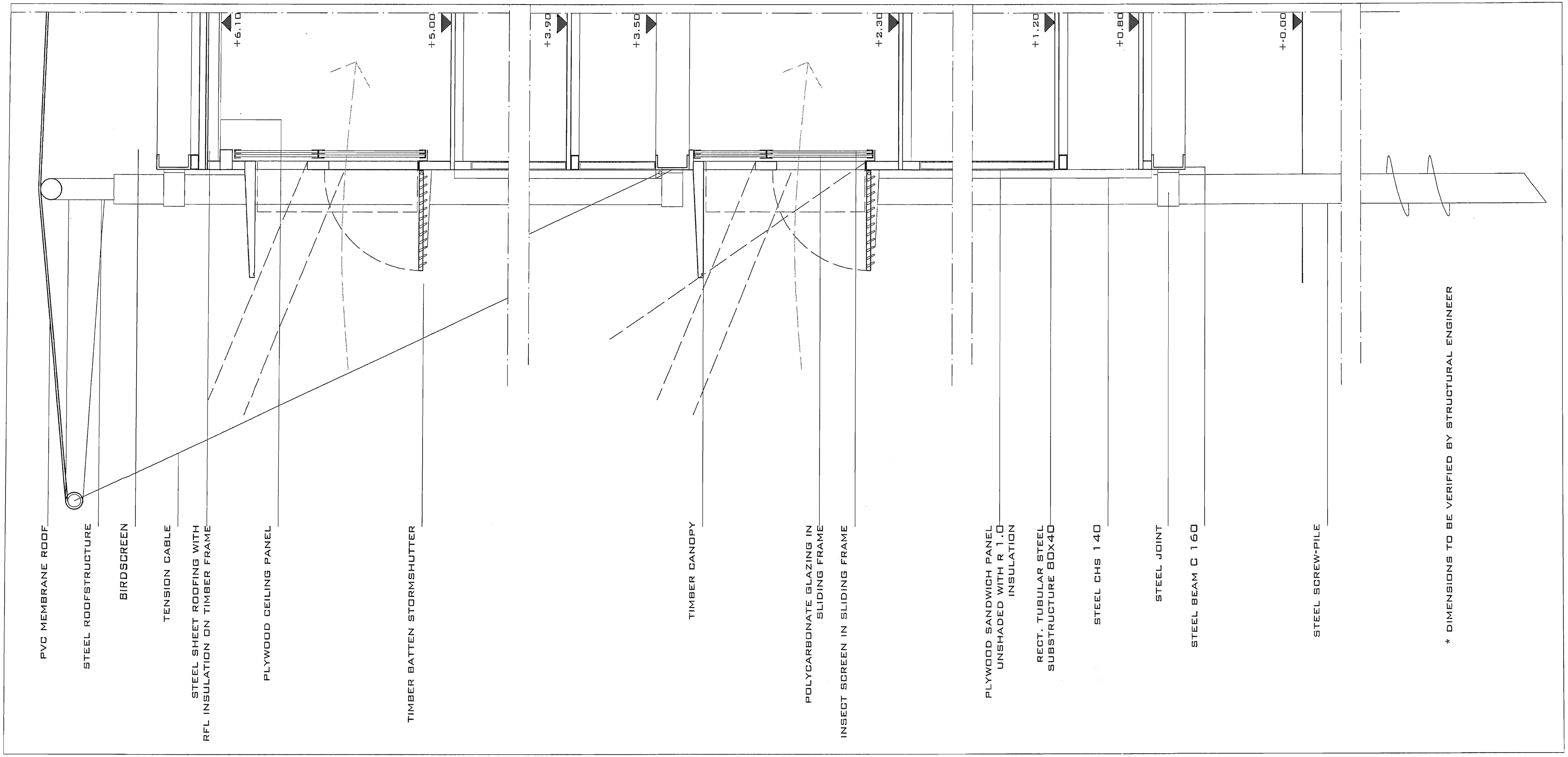


M Phil (by design)_ The University of Queensland_ Katrin Wichelhaus August 2003

1.13_ accommodation facilities @ HIRS _ standard section C-C _scale 1:50

Fig.81

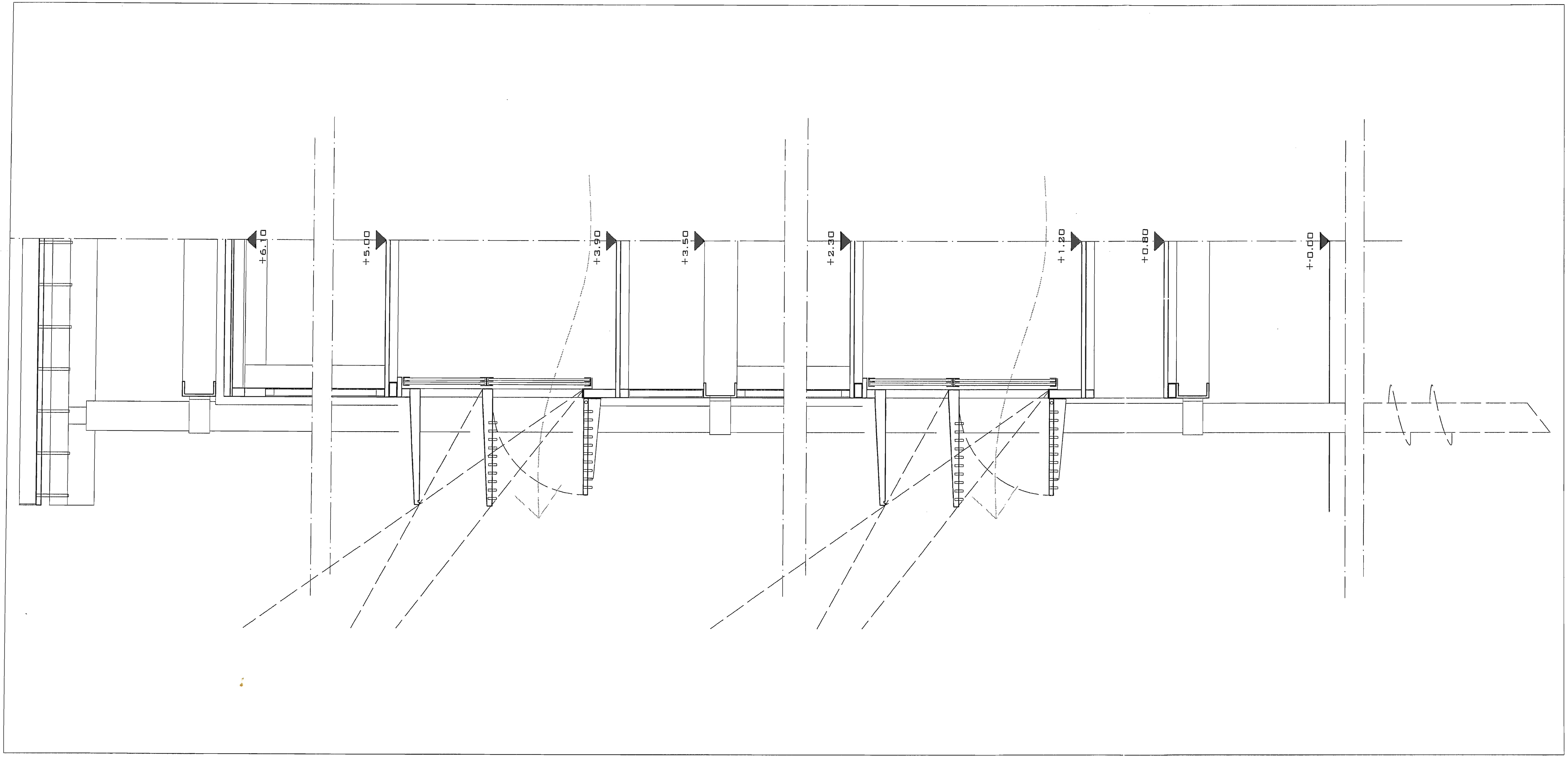
M Phil (by design)_ The University of Queensland_ Katrin Wichelhaus August 2003



1.14_ accommodation facilities @ HIRS _wall section south _ scale 1:20

Fig.82

M Phil (by design)_ The University of Queensland_ Katrin Wichelhaus August 2003



1.15_ accommodation facilities @ HIRS _wall section west _ scale 1:20

Fig.83

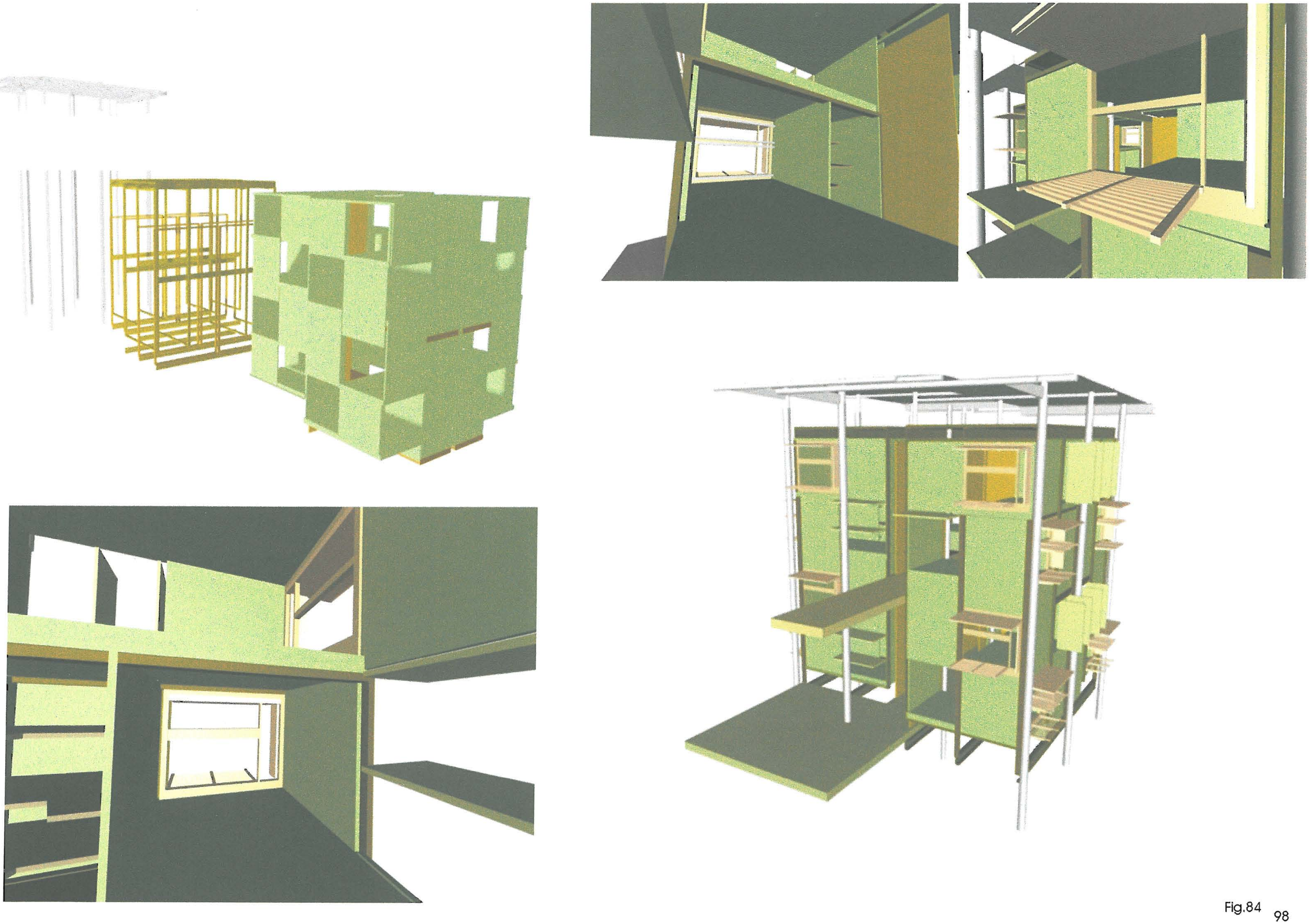


Fig.84

Tab.5	floor area	ceiling height	accommodation	environment	relationship to other areas	furniture/ equipment	indoor finishes	outdoor finishes	services
dormitory 1	25m²	2.5m	8 students	insulation in roof and exposed walls, cross-ventilation, fans	relationship with outdoors, space separation for 2,4,8 people	8 beds, shelves/ waredrobes	plywood, timber frame, timber flooring	plywood, steel frame, polycarbonate glazing, timber shutters and doors	electric power/ light
dormitory 2	25m²	"	"	"	"	"	"	"	"
dormitory 3	25m²	"	"	"	"	"	"	"	"
dormitory 4	25m²	"	"	"	"	"	"	"	"
dormitory 5	25m²	"	"	"	"	"	"	"	"
dormitory 6	25m²	"	"	"	"	"	"	"	"
dormitory 7	25m²	"	"	"	"	"	"	"	"
dormitory 8	25m²	"	"	"	"	"	"	"	"
outdoor circulation	~60m²			night lighting, partly covered				timber flooring (recycled)	electric power/ light
total student acc	**260m²**		**64 students**						
cabin 1	12.5m²	2.5m	4 teachers/tutors	insulation in roof and exposed walls, cross-ventilation, fans	reasonable distance to dormitories	4 beds, shelves/ waredrobes	plywood, timber frame, timber flooring	plywood, steel frame, polycarbonate glazing, timber shutters and doors	electric power/ light
cabin 2	12.5m²	"	2 teachers/tutors	insulation in roof and exposed walls, cross-ventilation, fans + disabled access	"	2 beds, shelves/ waredrobes	"	"	"
teacher amenities	8m²	"		disabled access		sanitary euipment for disabled people	"	plywood, timber frame	electric power/ light, c/h water + drainage
circulation space	~5m²			night lighting, partly covered				timber flooring (recycled)	electric power/ light
total teacher acc	**38m²**		**6 teachers/ tutors**						
outdoor recreation	~30m²			shaded platforms, night lighting, partly covered	central to dormitories, embedded in vegetation	seating		timber flooring (recycled)	electric power/ light
total	**328m²**								

3_4 Laboratory Facility Design

3_4_1 Design Response

As described in the section on site planning, the laboratory facilities are dispersed over two separate buildings and an extended outdoor space. Elevated walkways and a central platform connect all involved buildings at a height of about 0.80m creating quick connections between research and teaching facilities and common services. Outdoor bench space, equipment and tanks are concentrated on the platform and under the laboratory building. The platform is on a lower level so that access is limited and the main circulation remains separate. During the day the platform is largely shaded by a tall Pisonia tree in front of the teaching facility and by adjacent buildings. In the case of cyclonic weather, moveable tanks can be stored under the elevated building. Roller shutters allow this space to be closed up during storms and also permit different lighting levels, important for appropriate species storage.

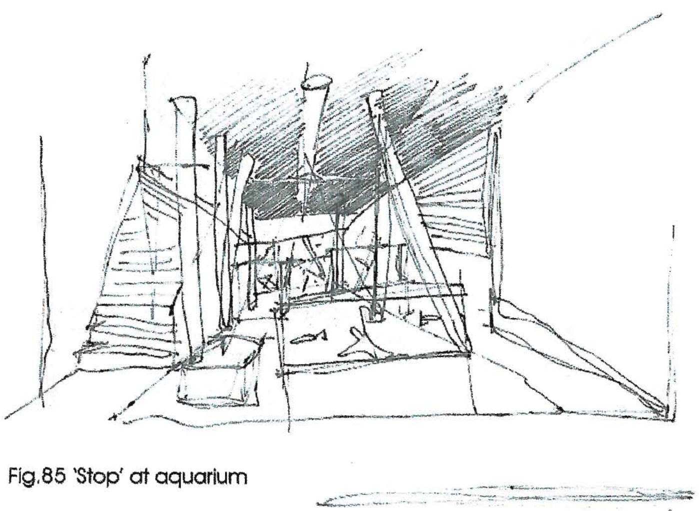


Fig.85 'Stop' at aquarium

In addition to researcher and student circulation, visitors will be guided through the research station. Therefore, the walkway is designed in sequences with three 'stops' each suggesting different environmental experiences. The visitor's tour starts at the station's entrance where basic information on the Heron Island Research Station is provided in an 'info box', a light timber framed structure with devices for display. The walk continues on the verandah in front of the teaching facility offering a broad view through the central courtyard space and leads the visitor into the cool environment of the wet laboratory under the elevated building. At this 'stop' visitors will have a look at the main aquarium in one direction, and in the other they will view a forest of columns, tanks and distant trees. Along the platform visitors will finally arrive at the third stop, which is defined by a timber batten screen that has seating on one side and a

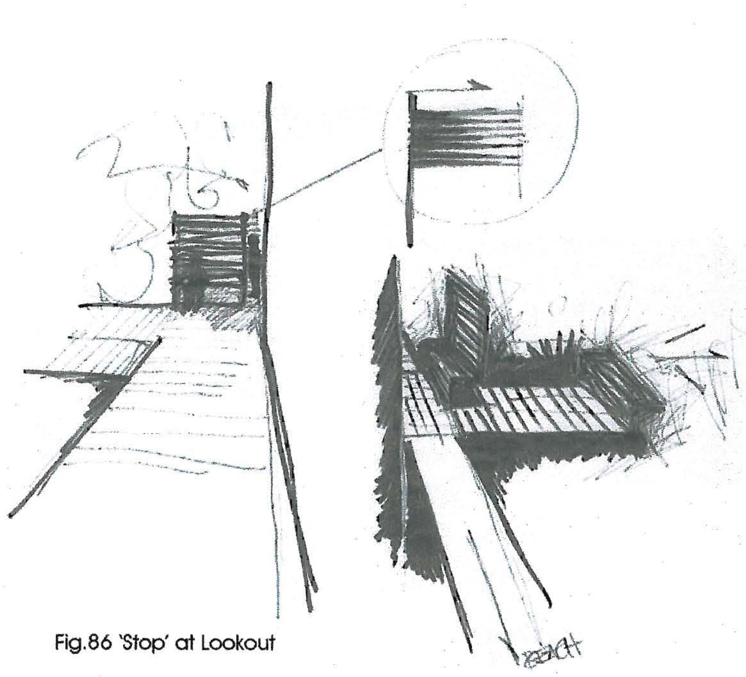


Fig.86 'Stop' at Lookout

lookout space at the back. From this point, visitors will go down a ramp behind the seminar building which takes them through the forest back to the beach.

In order to distinguish student and researcher functions, commonly used facilities are concentrated in the seminar building and the elevated building. The first level of the seminar building remains an equipment store; the second level serves as a library including a number of student computer stations. On its upper level, the seminar building is connected to the elevated building so that the existing external stairs provide access to both buildings.

The laboratory is a two-storey block with an elevated extension towards the entrance. The elevated part allows spatial continuity between kitchen and teaching facility and provides additional outdoor dining space underneath. The lower laboratory level is principally accessed from the platform, the upper level from outdoors by stairs at the eastern side of the building. A passage between the laboratory and the salt water tank connects the platform to the path and the services in the ablutions block.
The laboratory accommodates open-space dry laboratories on each floor with bench bays on a grid of 3.0m, running along the screened northern facade. To avoid a detached instrument laboratory, all equipment and service pipes are concentrated in a service wall on the southern elevation. This wall acts as an interactive element between in- and outdoor working areas, providing access to sinks and services from the outer platform. All service pipes pass under the elevated structure which eliminates excavation works.

The laboratory building requires air-conditioning for most of the year. To increase the efficiency of the active cooling system, the building design includes strategies of shading and zoning. While the eastern and western elevations remain closed to

Fig.87 Schemes Laboratory

reduce cooling loss, the glazing on the northern facade is rigorously shaded by a fabric screen which diffuses entering sun light.
The elevated part of this building can be internally separated from the open-space laboratory on the upper level so that the air-conditioned zone can be reduced when the laboratory is not fully occupied. Cooling equipment and the walk-in cold/ dark room are centralized in one laboratory section on the first level.

The building next to the seminar building and the teaching facility, on the other hand, can either be air-conditioned or naturally ventilated. With screened openings on the short sides and a partition wall of ¾ height to allow air-flow between computer room and office, the building takes advantage of the prevailing breezes. A 'switch system' is proposed which can be changed manually or automatically between both systems. Control mechanisms such as thermostats are installed to achieve the best possible performance. Wide roof overhangs shade openings on the eastern facade.

3_4_2 Construction and Materials

Screw-piles elevate the laboratory building on a level at 0.80m. The primary structure is composed of laminated I-beams which allow long spans with small sections. The timber frame is clad in prefabricated plywood sandwich panels with sufficient insulation. Standard windows are used throughout the building. Timber flooring is finished with linoleum on both levels to provide easily cleanable and chemical resistant surfaces. Reflective ceilings improve the intensity of the day lighting. The largely prefabricated system provides a simple, insulated steel roof enclosure. A second roof layer protects this structure against heat gain and rain.

The construction of the elevated building next to the teaching facility is similar to that of the laboratory. Only the steel roof and the columns in the wet laboratory space under the building are different. To increase the effect of the forest scenery in this space the columns used are most similar to natural trunks.

3_4_3 Environmental Performance

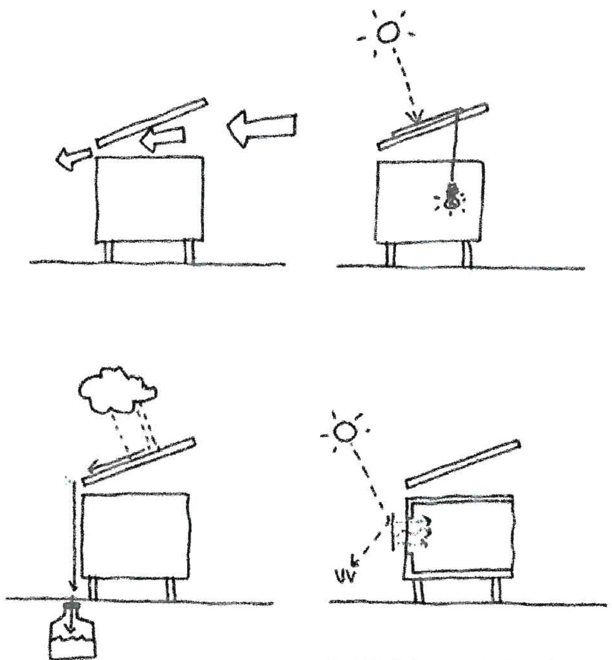


Fig.88 Schemes Laboratory

The parasol roof of the laboratory building is made of a steel frame that is covered to the maximum with building integrated photovoltaic (BiPV). Highly efficient amorphous silicon is used for the grid connected solar array.

Integrated Energy Systems (IES) investigated possible energy strategies for the Heron Island Research Station and claim renewable energy generation from solar systems like Photovoltaic (PV) and solar heating systems to be the most appropriate for an application on Heron Island. PV modules have not only environmental but also economic benefits. With a working life of more than 20 years, they need little maintenance. Maintenance only requires that tree shading is reduced and that the panels are regularly cleaned of dirt, especially bird waste. IES explains:

> ... a solar array could be used to supplement the electricity being supplied by P&O. Where there is power being generated by the array, it would be used first, reducing the demand on the P&O supply. At night, or when there is no solar input, the total load would be taken from P&O.[10]

Energy generation from wind or tidal energy is not appropriate for Heron Island. Wind generators would endanger bird life and cause noise impacts on people and wildlife. Due to the building regulations, they cannot be placed above the tree line where they

[10] Jody Finsen and Trent Whyte, Integrated Energy Systems (IES), Heron Island Research Station Upgrade- ESD and Energy Management, March 2003

would be most effective. Wave power is not feasible as it requires constructions within the sea and therefore causes major environmental impacts.

In addition, the laboratory roof and also the roof of the elevated building are used to harvest rainwater. Even though the water quality is reduced due to bird contamination, the resource is important for activities that do not require potable water such as washing, cleaning and gardening.

In accordance with the second recommendation from IES, a water-cooled air-conditioning system has been chosen which reduces impact and increases energy efficiency. Seawater is pumped through the heat exchanger to cool the water in the system. Because of the larger temperature difference between seawater and condenser, the water cooled system is about 20% more energy efficient than an air-cooled system.[11] Control mechanisms are installed to allow the most efficient performance.

Similarly, the efficiency of the lighting in- and outside the laboratory is increased by motion and light sensors. It can be controlled by the user as well as automatically. Compact fluorescent lamps (CFL) are used in all indoor spaces. Outdoor night lighting is restricted to the use of intermittent, low pressure sodium light.

Although air-conditioned and sealed to achieve sterile research conditions, the design of the laboratory building focuses on the envelope, such as the roof and the facades. The design provides maximum outdoor space which allows for interaction with the environment. The impact on plant and animal life will be reduced as human action is

[11] Jody Finsen and Trent Whyte, Integrated Energy Systems (IES), Heron Island Research Station Upgrade- ESD and Energy Management, March 2003

concentrated on the platform. This elevated layer, as well as the service wall, is used to create spatial continuity between indoor and outdoor working spaces. The central courtyard becomes the communicative forum of the Heron Island Research Station.

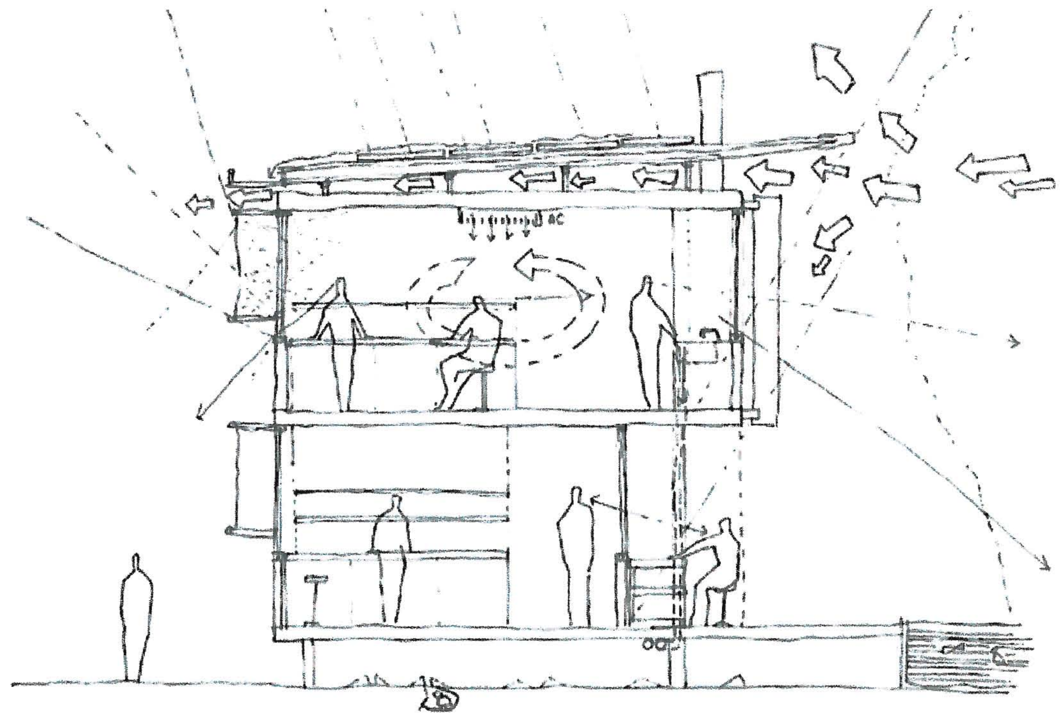


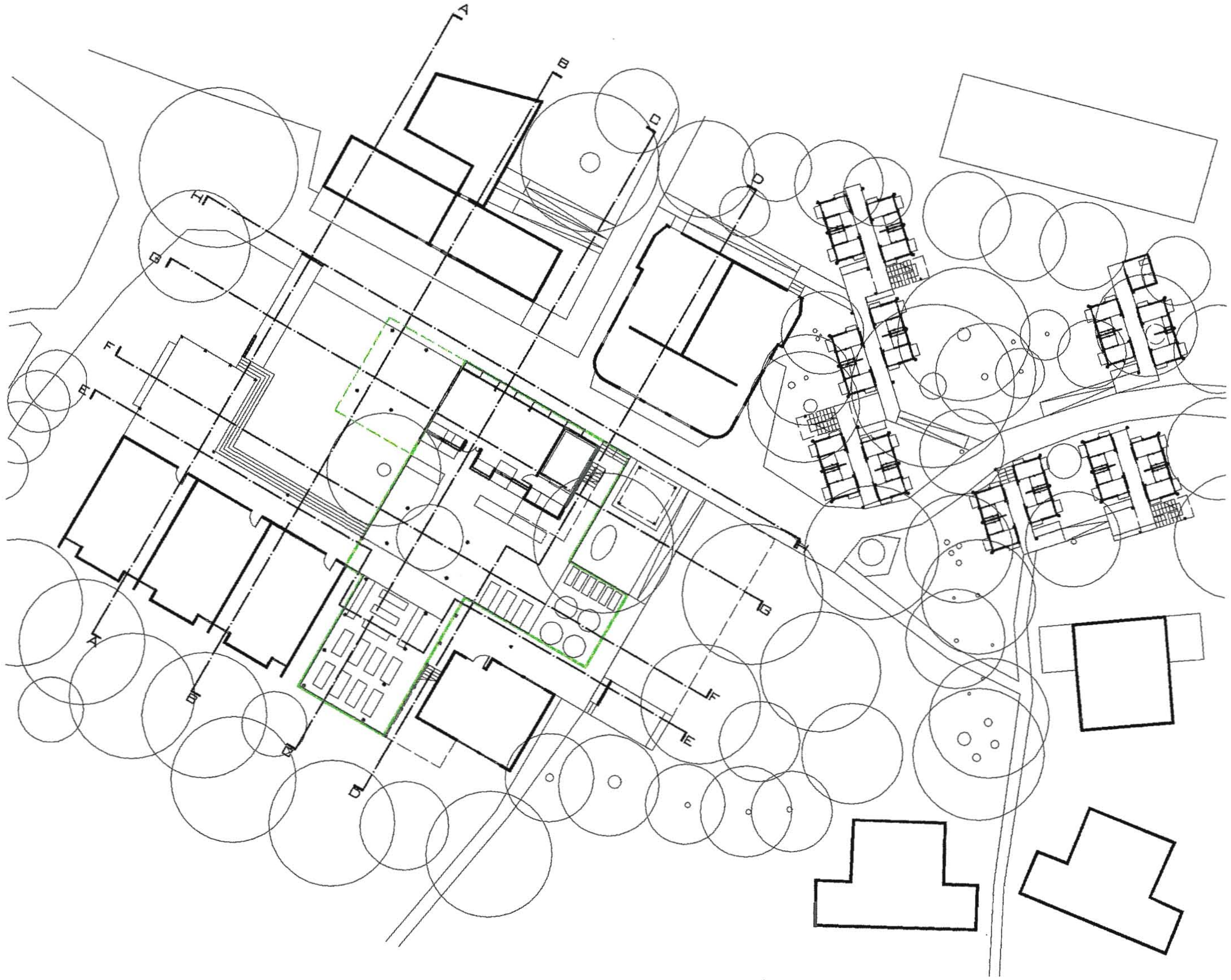
Fig.89 Performance

3_4_4 Project Drawings

Please see Fig. 90-102 and the summary sheet in Tab.6.

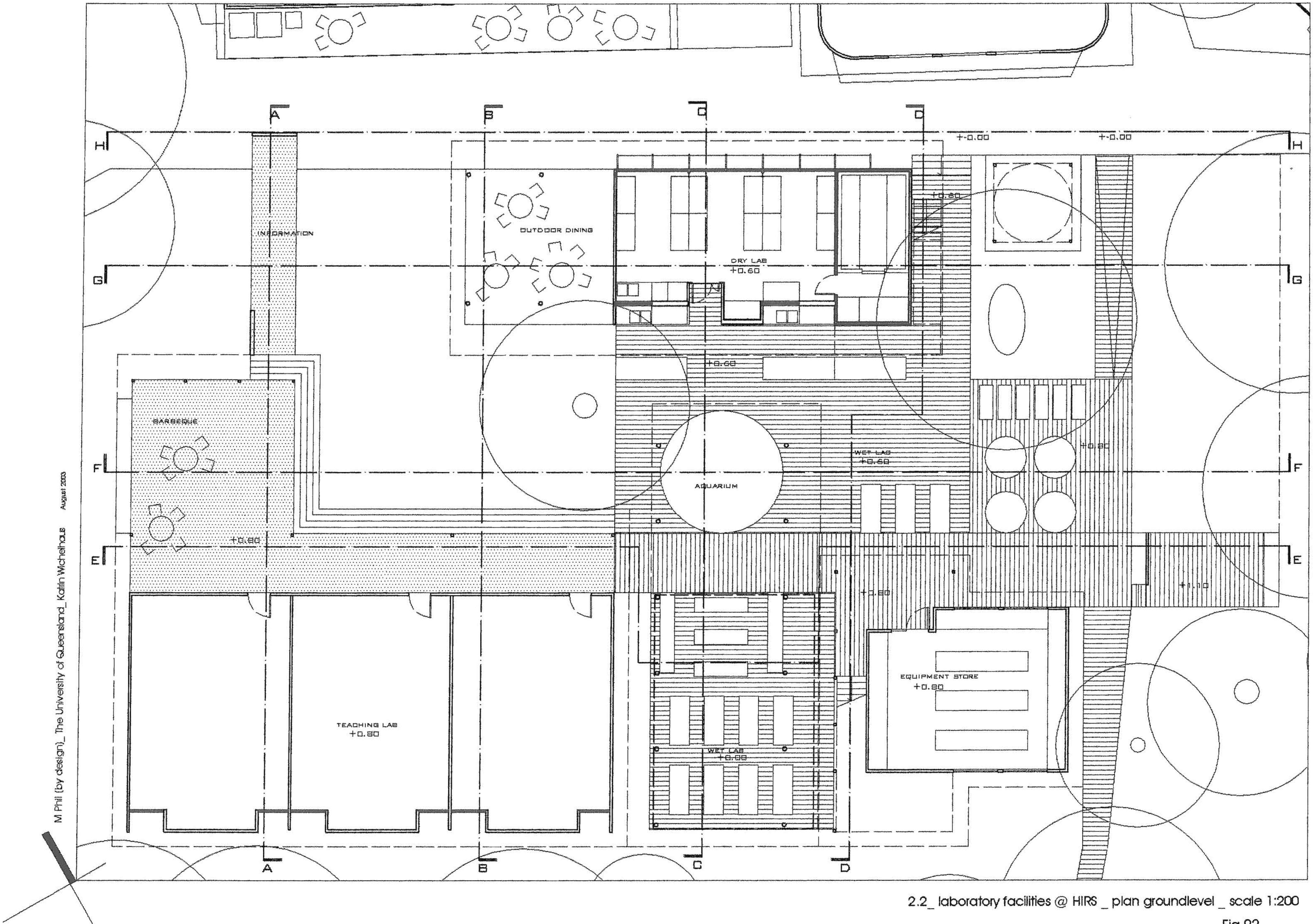
0.1_ accommodation and laboratory facilities @ HIRS _ general plan _ scale 1:500

Fig.90



2.1_ laboratory facilities @ HIRS _ general plan _ scale 1:500

Fig.91



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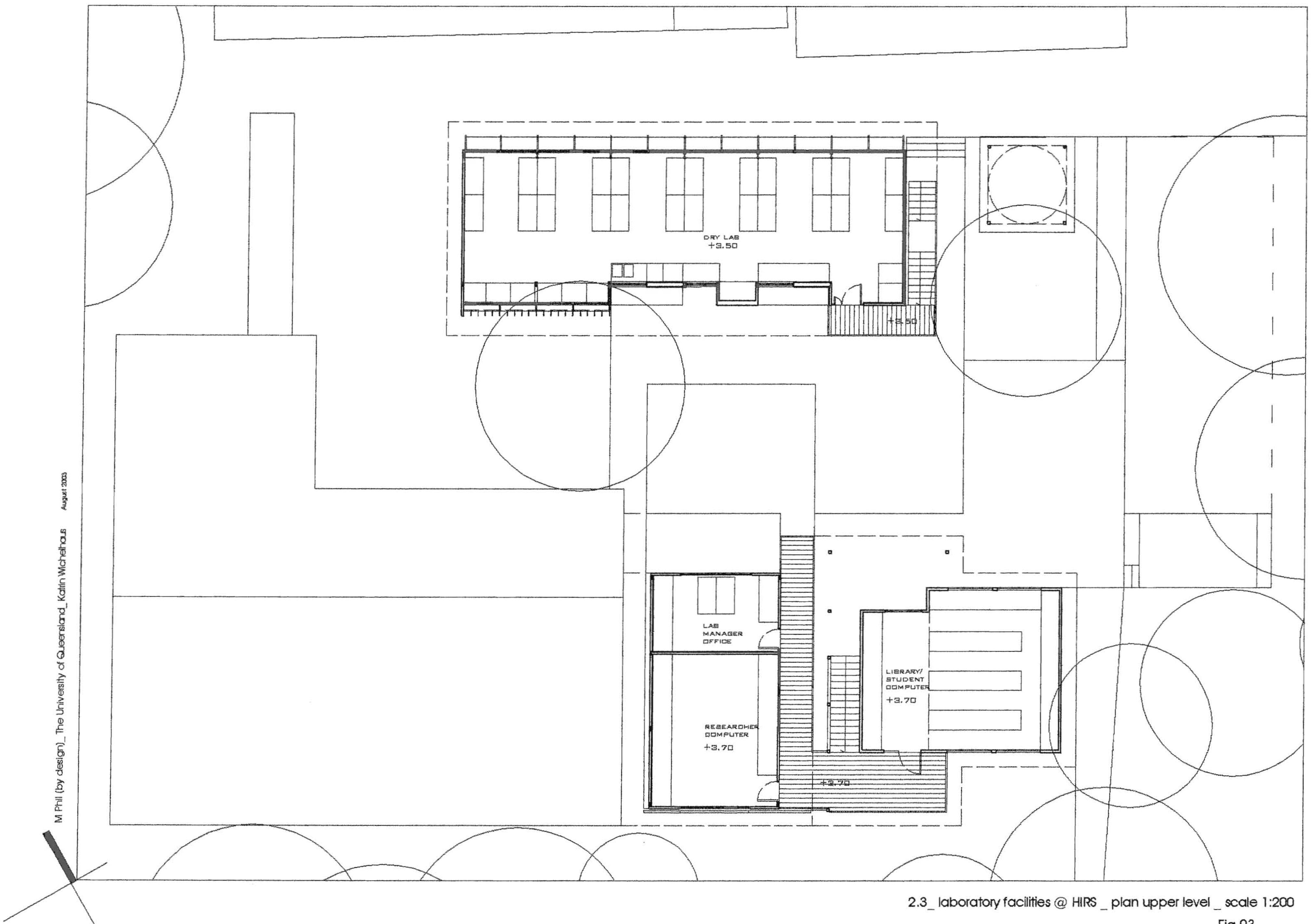
2.2_ laboratory facilities @ HIRS _ plan groundlevel _ scale 1:200

Fig.92



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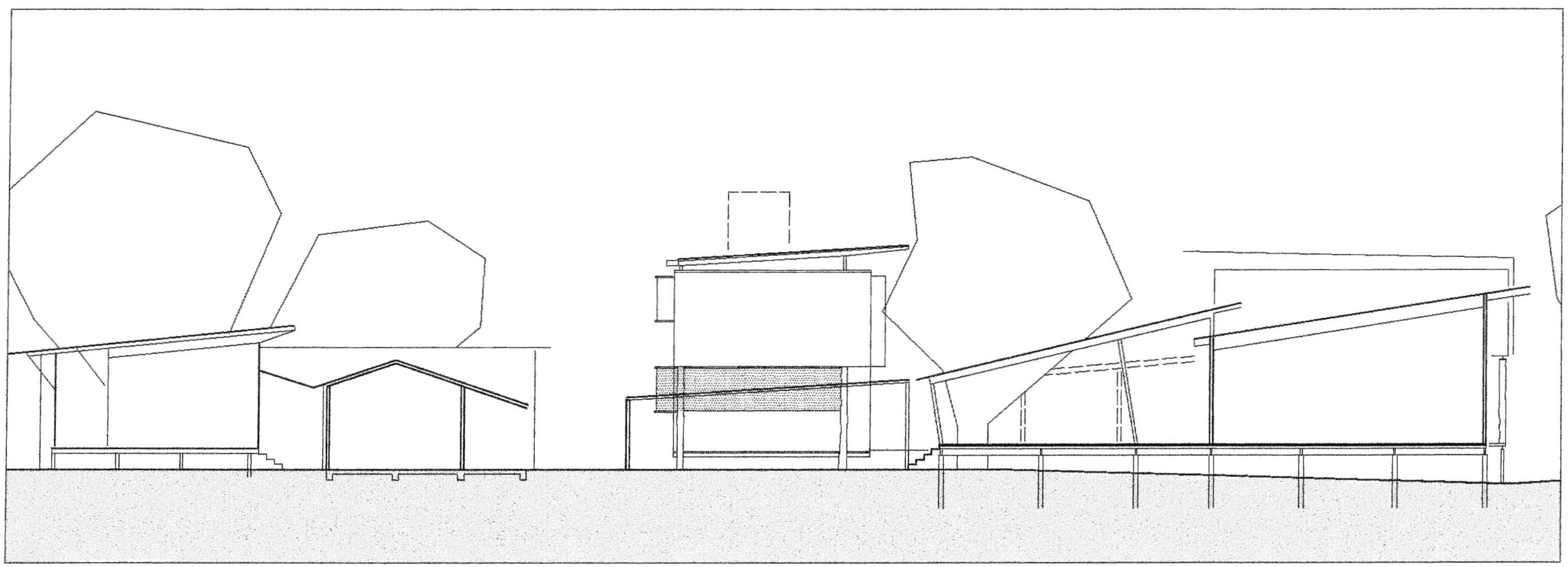
2.3_ laboratory facilities @ HIRS _ plan upper level _ scale 1:200

Fig.93

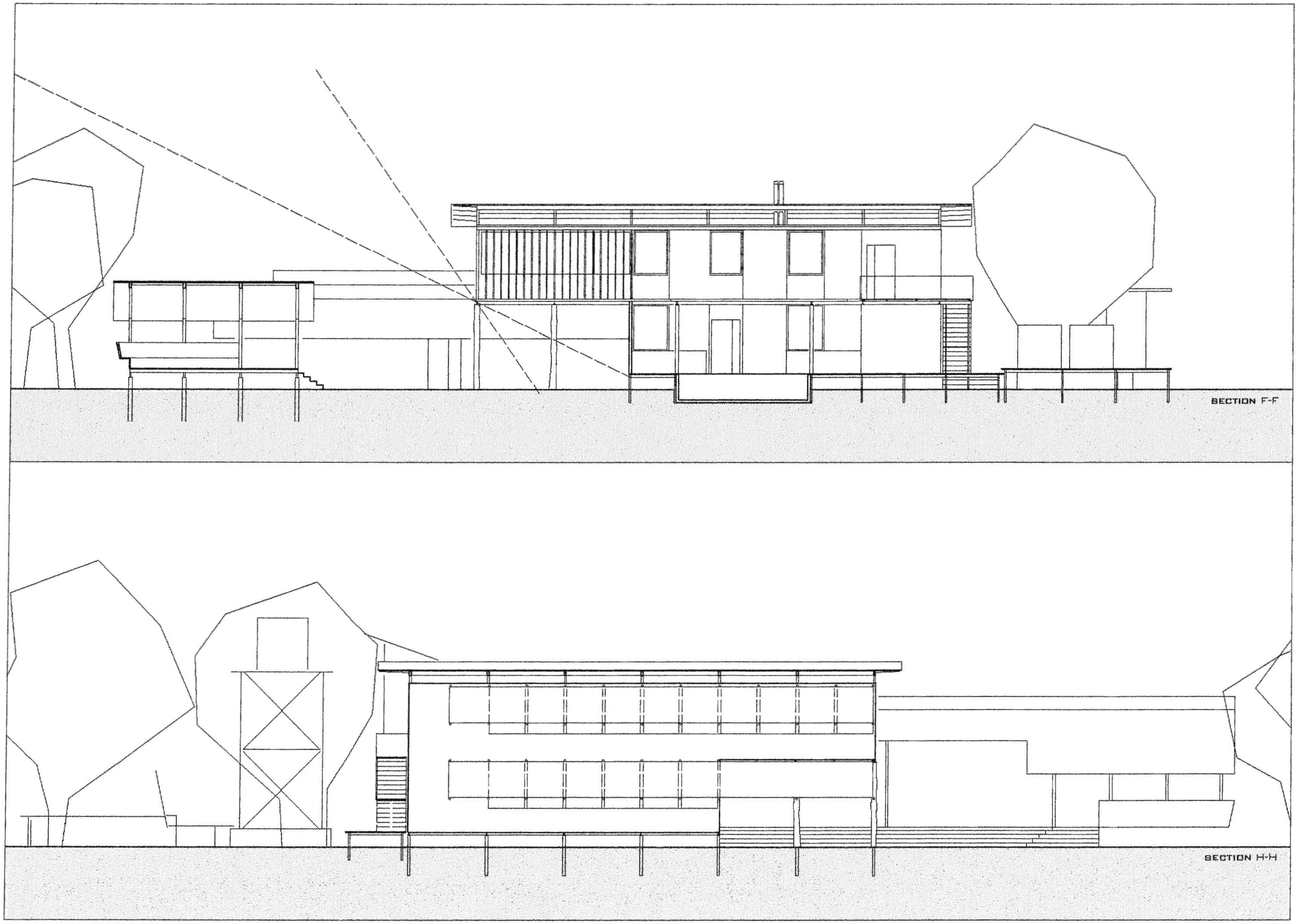


2.4_ laboratory facilities @ HIRS _ section A-A _ scale 1:200

Fig.94

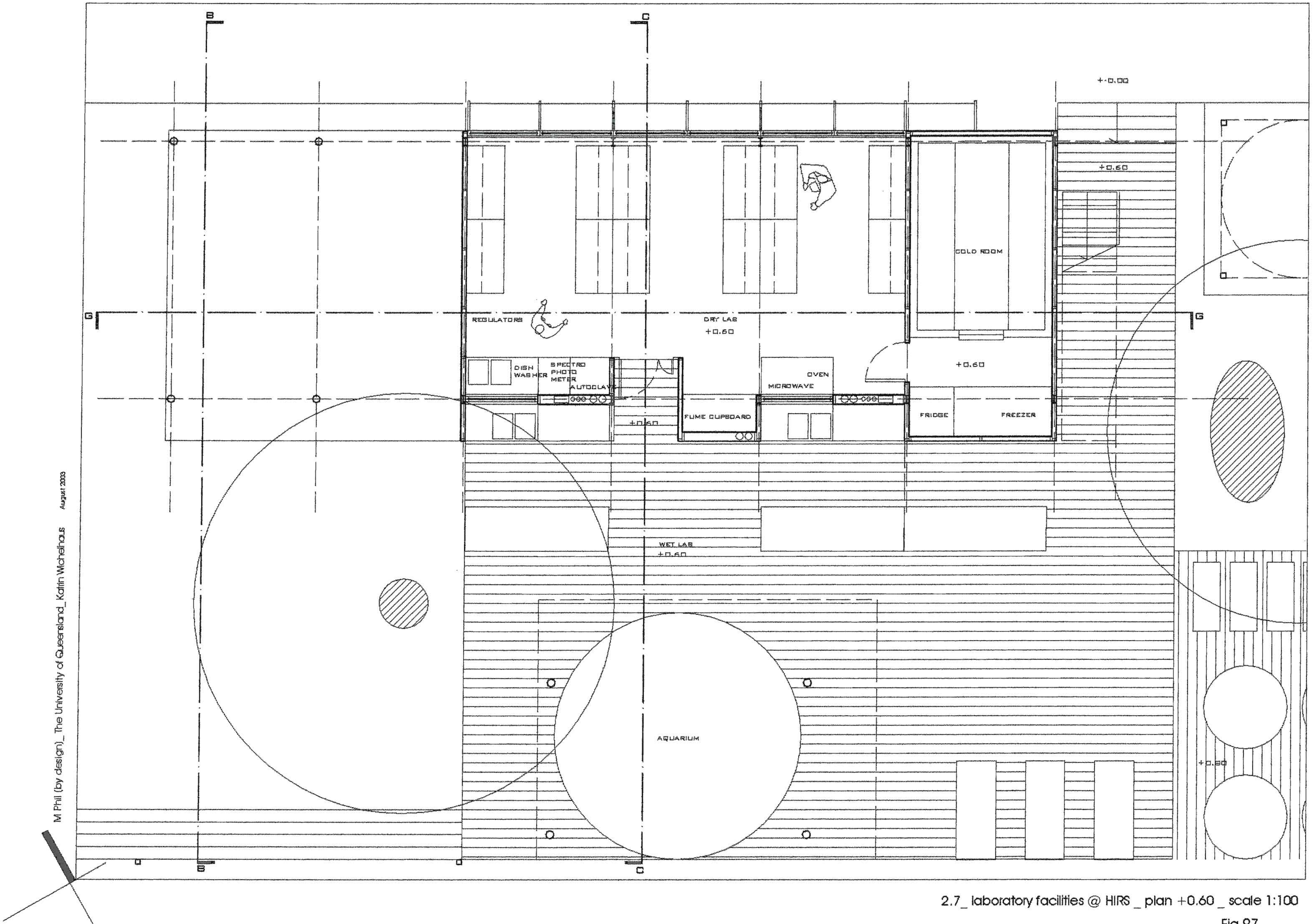
2.5_ laboratory facilities @ HIRS _ sections D-D/E-E _ scale 1:200

Fig.95



2.6_ laboratory facilities @ HIRS _ sections F-F/H-H _ scale 1:200

Fig.96



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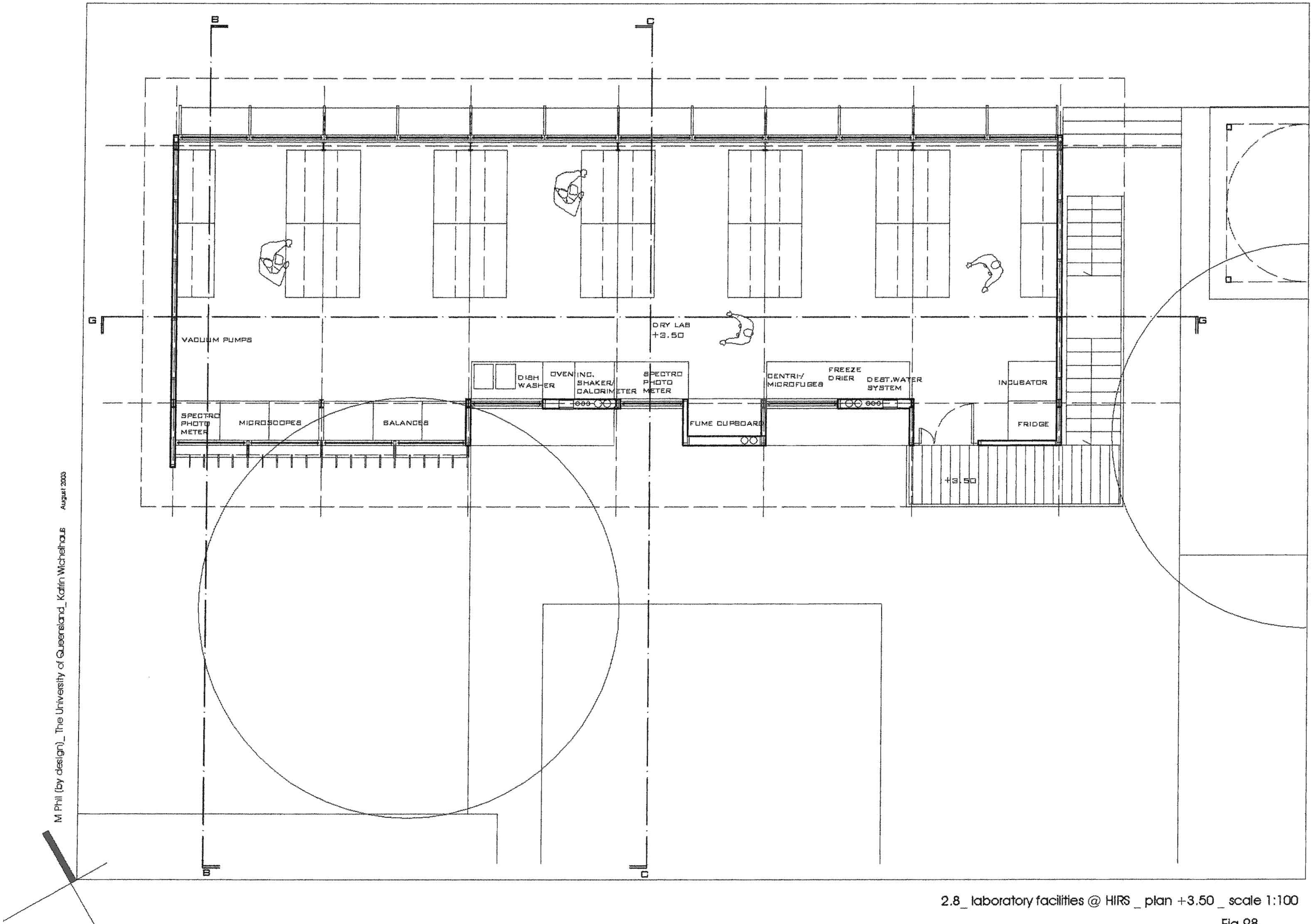
2.7_ laboratory facilities @ HIRS _ plan +0.60 _ scale 1:100

Fig.97



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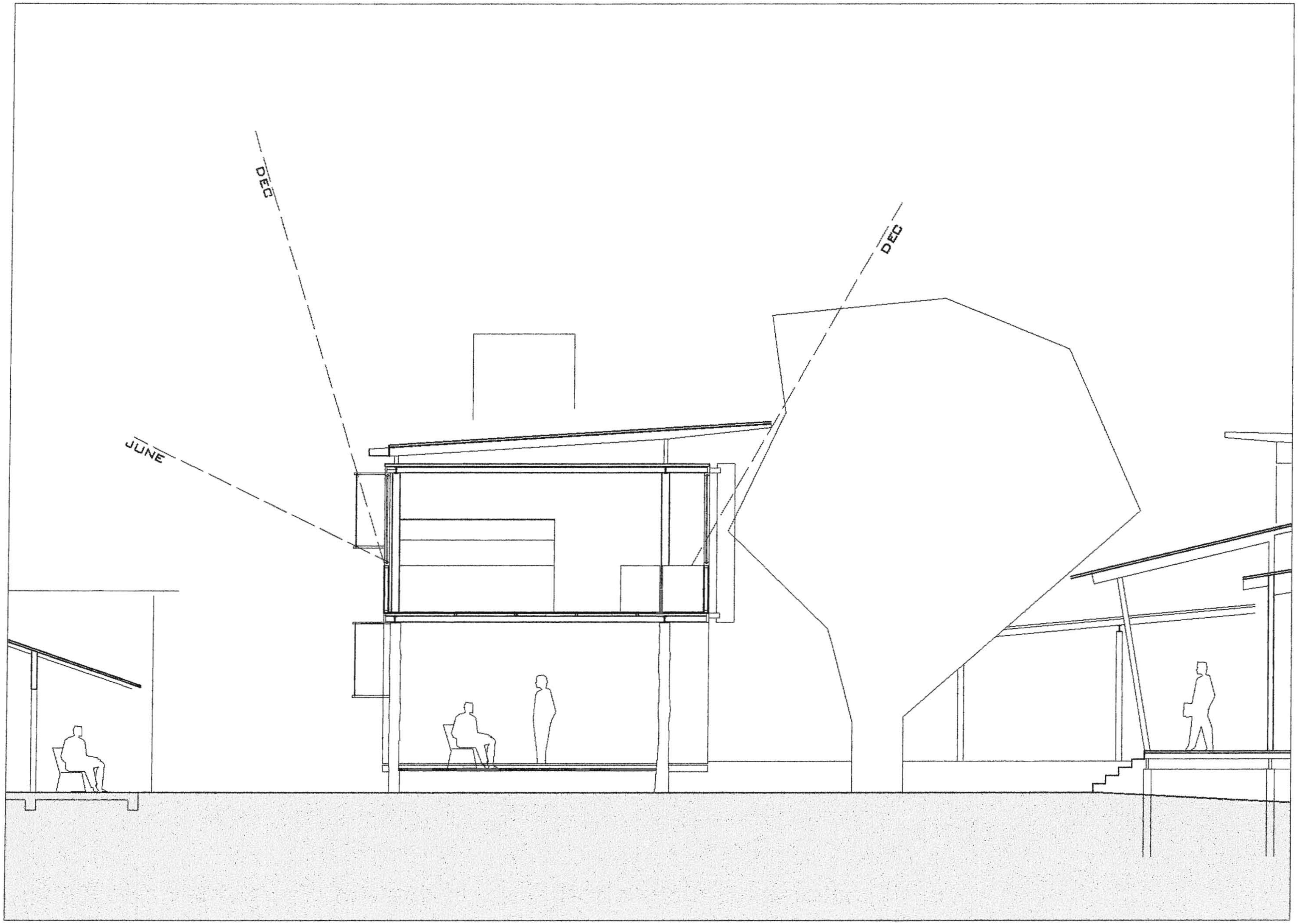
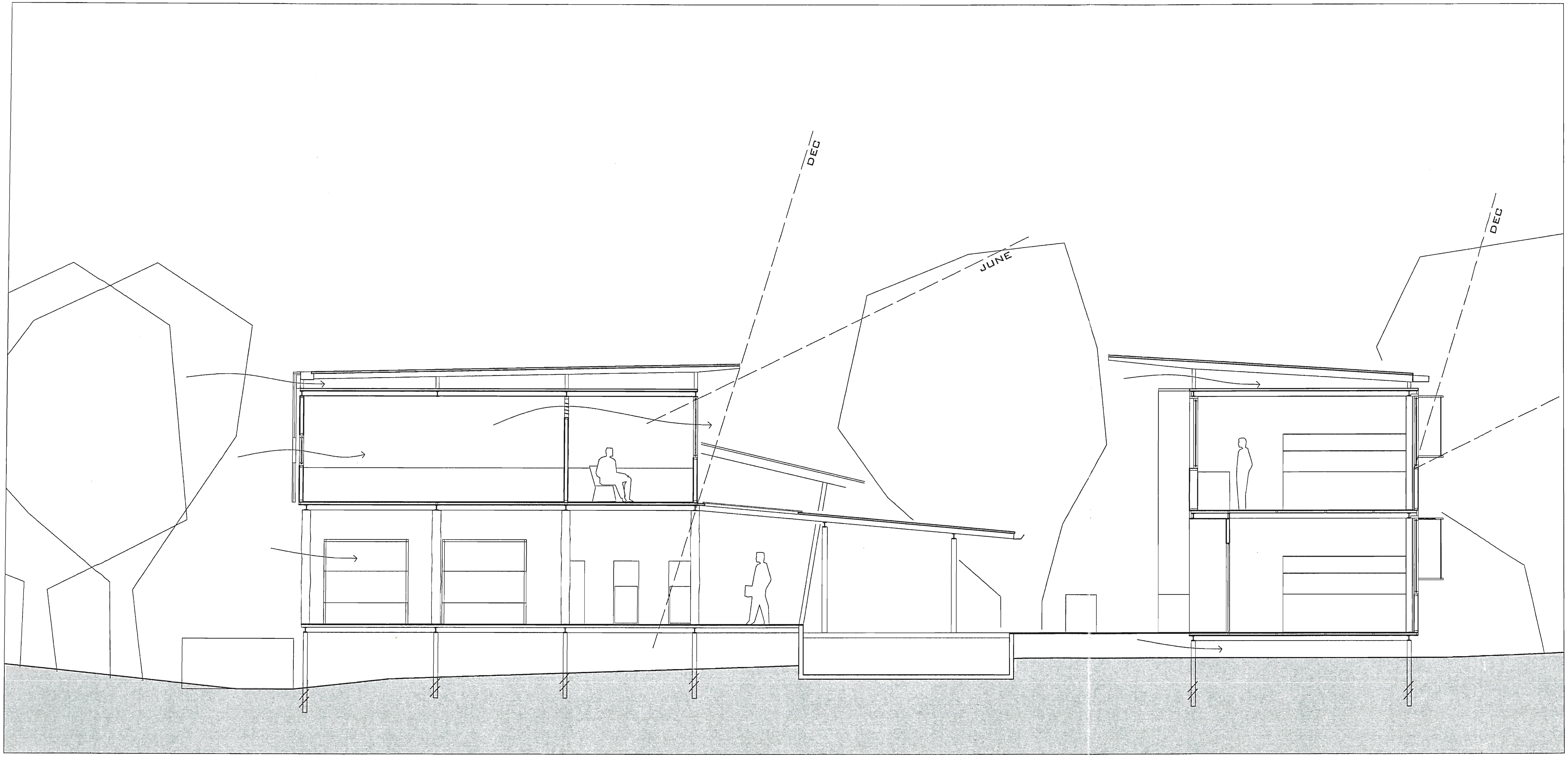
2.8_ laboratory facilities @ HIRS _ plan +3.50 _ scale 1:100

Fig.98



2.9_ laboratory facilities @ HIRS _ section B-B _ scale 1:100

Fig.99



2.10_ laboratory facilities @ HIRS _ section C–C _ scale 1:100

Fig.100

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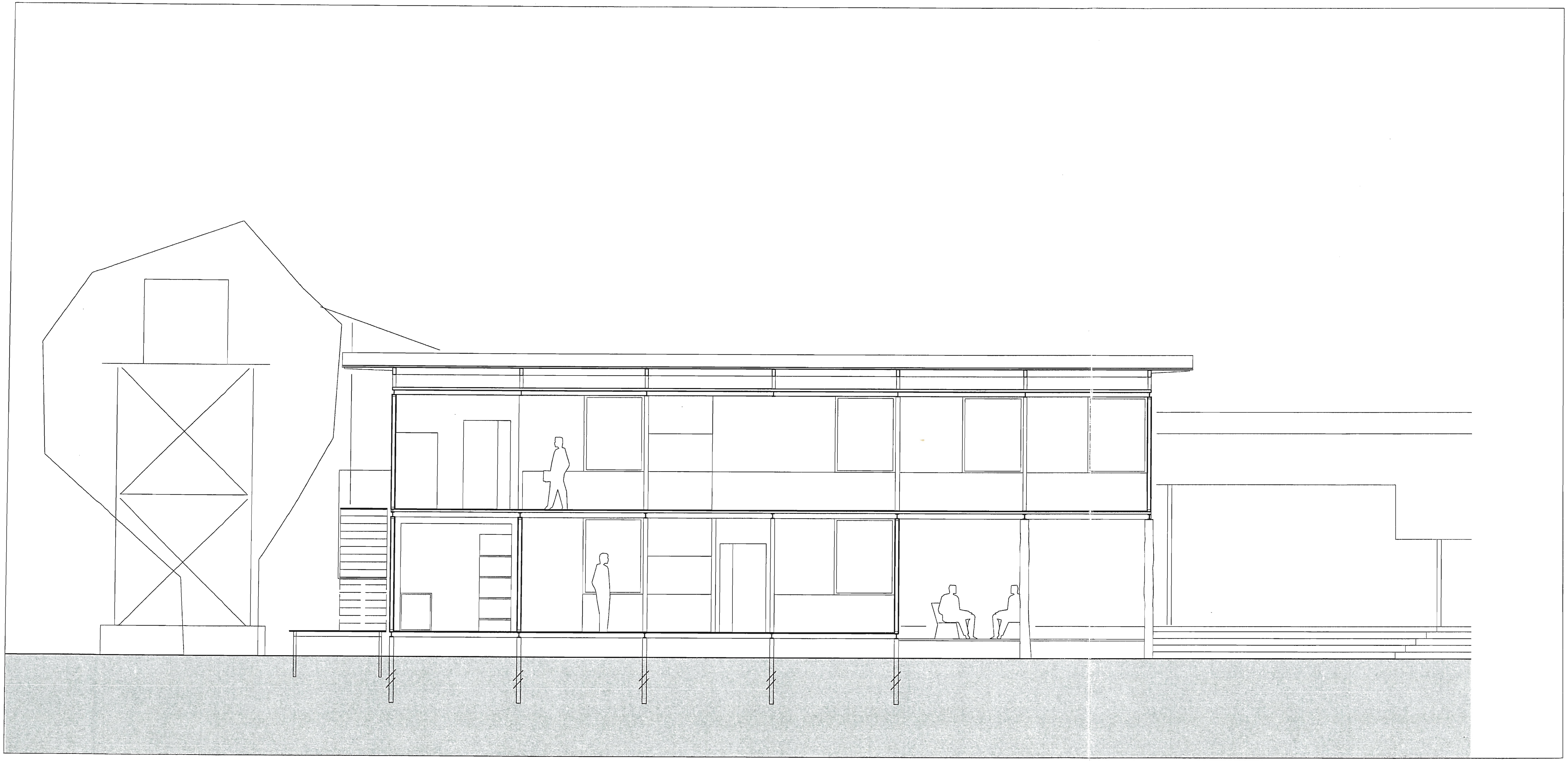


2.11_ laboratory facilities @ HIRS _ section G–G _ scale 1:100

Fig.101

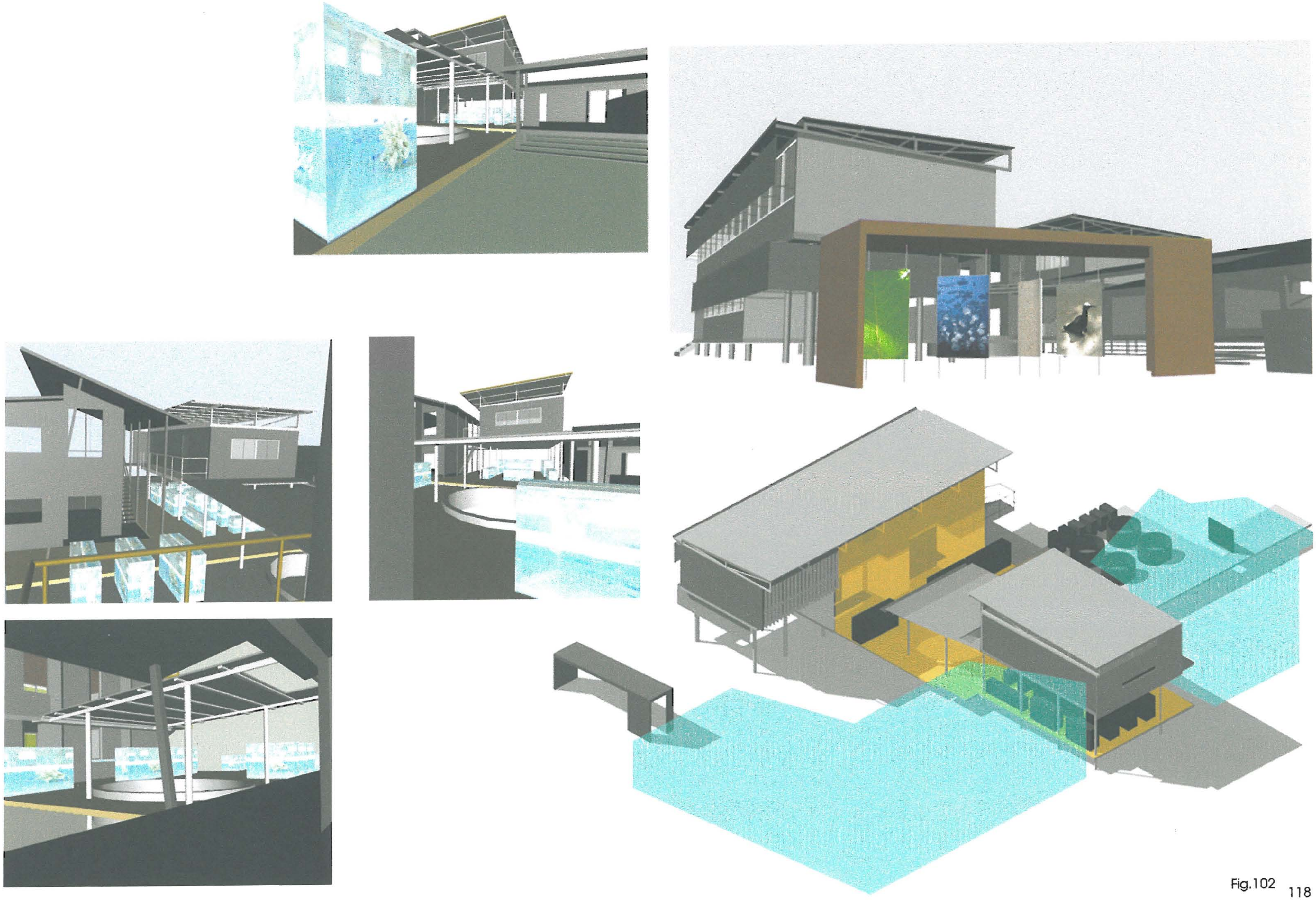


Fig.102

Tab.6	floor area	ceiling height	accommodation	environment	relationship to other areas	furniture/ equipment	indoor finishes	outdoor finishes	services
dry lab(open space) + instruments	165m²	2.7m	15-20 researchers (+research assistents)	daylighting, user+sensor manipulated lighting, air conditioning with control system, insulation in roof and exposed walls	access to wet lab and aquarium, swipe card access	movable island benches/ write-up (2x1.5m/person, adjustable height), over-bench shelves, technical equipment, benches for commonly used technical equipment (>0.75m), stable benches, waste containers, storage	LVL frame, ply clad, timber flooring with coved linoleum finish	plywood panels, sliding windows with fabric screen for shading, timber shutters	electric power/ light, c/h water + drainage, salt water + drainage, communication
walk-in **cold room**	10m²	2.5m		total temperature control, dark room		1 person bench space, shelving	prefabricated cell	prefabricated cell	electric power/ light
total laboratory building	**175m²**								
lab manager office	15m²	2.5m	2 staff	daylighting, air conditioning/ natural ventilation, insulation in roof and walls	overlooking wet lab	2 workstations, storage for special equipment (cameras)	ply panel walls, timber flooring with linoleum finish	ply walls, sliding windows with shading devices	electric power/ light, communication
researcher study	33m²	2.5m		"	swipe card access	10 computer workstations, printer, scanner, photocopier, desks, seats	"	"	electric power/ light, communication
total lab facility	**48m²**								
library	35m²	>2.7m		daylighting, air conditioning in existing seminar building	swipe card access	bookshelves, desks, seats, computer station	existing timber finish with linoleum floor	existing timber finish, existing windows to be replaced with double glazed sliding windows with shading devices	electric power/ light, communication
student study	15m²	>2.7m		"	"	6 computer workstations, printer, desks, seats	"	"	electric power/ light, communication

equipment store	50m²	2.7m		air conditioning in existing seminar building	direct access to wet lab, swipe card doors	equipment in standard cupboards, glass store, computer station	"	"	electric power/ light, communication
total sem. building	**100m²**								
outdoor circulation	~50m²			reduced night lighting, partly covered				timber flooring (recycled)	electric power/ light
wet lab(open space) **and aquarium**	220m²	2.7m		outdoors, partly covered, reduced night lighting	centrally located, limited access for visitors	covered aquarium 5.0x5.0m, different sized tanks+structure, fixed and movable benches, movable under bench store elements, equipment		easily cleanable surfaces, removable enclosure through roller shutters, timber decking (recycled)	electric power/ light, c/h water + drainage, salt water + drainage, communication
total	**593m²**								

Part 4_ Conclusions>

In order to rate the sustainable approach of this project, the Green Globe Certification checklist is used as a reference. The test shows that the design addresses all issues. Focused on strategies that help to minimize the impact on the local eco-system, the design response emphasizes some of the areas. Please see Tab.7.

Point A asks for sustainability goals and an interdisciplinary design approach, which are covered by both the brief and the research.

Point B, the siting suitability and environmental siting attributes, has been comprehensively studied as they are a principal concern on Heron Island. The footprint is analyzed in Fig.103.

Point C requires strategies to reduce the operational energy consumption by about 30%. This design proposes passive design strategies for the accommodation, as well as for the laboratory building, which minimize energy consumption and increase energy efficiency. The application of amorphous silicon cells (PV) covering the entire laboratory roof offers the basis for a long-term solution that uses renewable energies and reduces dependence on the energy supply from diesel generators.

Point D describes the objective of minimizing the consumption of potable water and reducing the amount of solid waste. This design proposes rainwater collection strategies for the roof surfaces of both facilities to complement the water supply from the resort's desalination system.

Tab.7_Green Globe Certification Form>

The Reference for the Indicator	Affiliation Stage 1	Benchmarking Stage 2	Certification Stage 3	Assessment Comments
A: Design Approach and Sustainable Policy				2 of 3
A1. Sustainability goals and vision in the design brief and undertaking of effective environmental management system		X		
A2. An operational statement for post construction project assessment, operational control and where appropriate, continual improvement of environmental and local impact				
A3. An interdisciplinary and coordinated approach between all design professionals		X		
B: Siting and Urban Issues				1of 1
B1. Appropriateness of site planning with regard to constraints and opportunities offered by the natural and built environment		X		
C: Energy Efficiency and Conservation				2 of 2
C1. Annual total operational energy consumption (GJ) per guest night or area under roof	Target: 30% reduction in energy consumption	X		
C2. CO^2 emissions details if appropriate (Fuel Break up)	Target: 30% reduction in CO^2 emissions	X		
D: Protection of air, earth and water				4 of 5
D1. Annual predicted potable water consumption per area under roof	Target: 60% reduction	X		
D2. Annual predicted volume of solid waste to land fill per area under roof	Target: 30% reduction	X		
D3. Annual predicted non-biodegradable chemical use per area under roof	Target: 0%	X		
D4. Measures taken for harvesting, use, re-use or recycle for on-site resources during the life of the building		X		
D5. CO^2 emissions details (Fuel Break up)				

E: Selection of Building Materials and Process				1 of 2
E1. Selection of green materials and process for low environmental impacts		X		
E2. Ecolabel products purchased				
F: Construction				4 of 6
F1. Construction Process management in place for environmentally responsible construction schedule				
F2. Contractor's experience (environment management) to be considered before job assignment (Tender requirement)				
F3. Specification of building systems and methods which reduce the energy consumption and waste during construction in the future		X		
F4. Water	Target: 35% reduction (KL per day)	X		
F5. Waste	Target: 35% reduction (KG per day)	X		
F6. Energy	Target: 35% reduction (KW per day)	X		
G: Social Issues				3 of 3
G1. Design measures to integrate contextual parameters		X		
G2. Minimal impacts on native land and population		X		
G3. Enhancement of the "user's " understanding and integration with the natural and social environments		X		

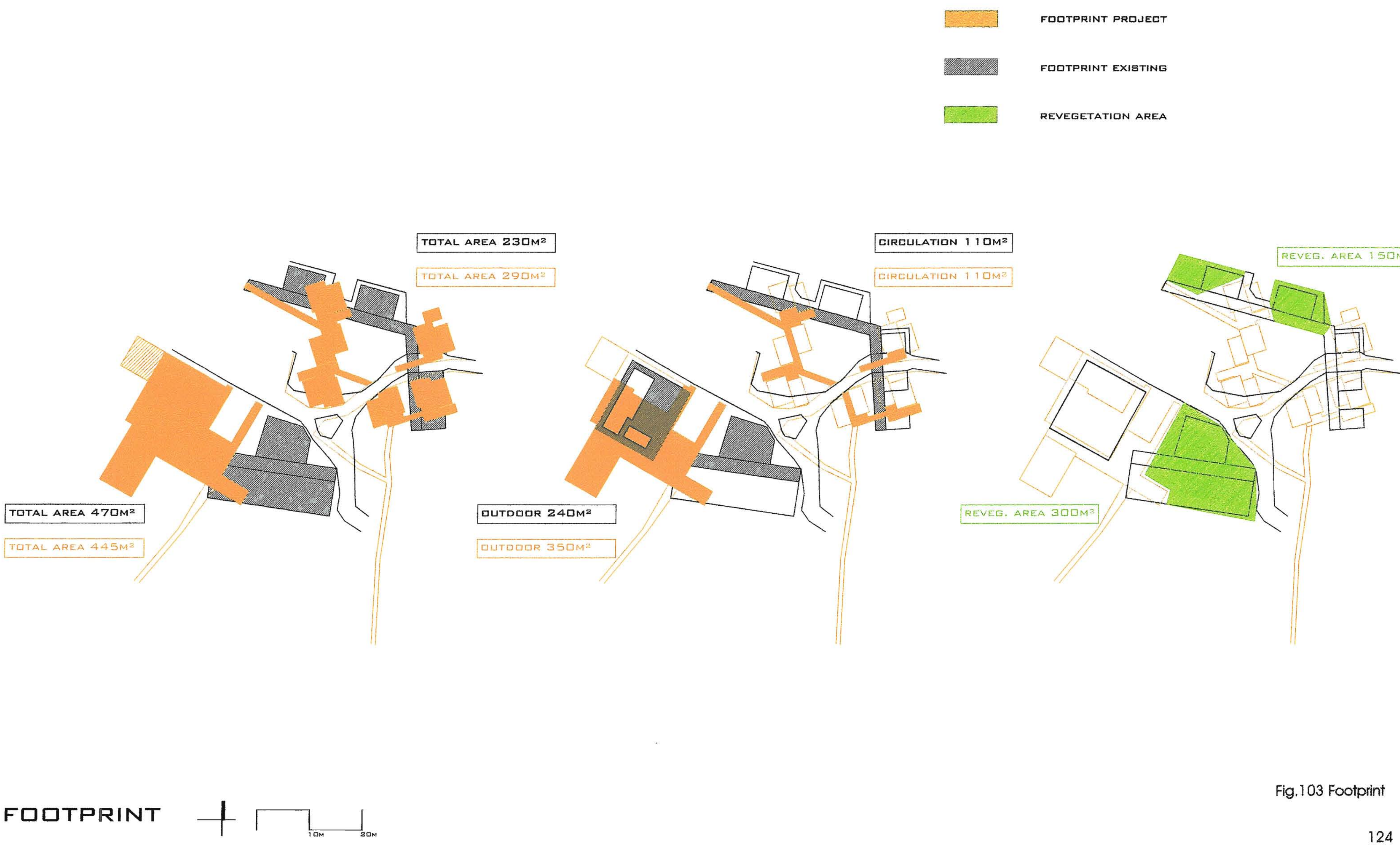


Fig.103 Footprint

Recycled grey water used for toilets and external taps is provided by the resort's tertiary treatment plant. The problem of solid waste is not adressed as this needs to be resolved in the broader context of the island. Actually, there are strict regulations that all waste has to be removed from the island.

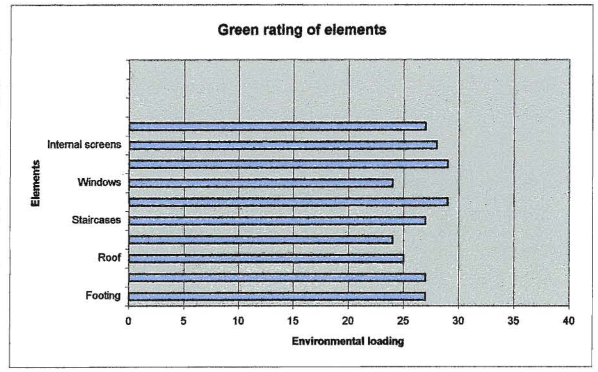
Point E concerns the selection of building materials with low environmental impact. The material rating in Tab.8 and Tab.9 shows that both buildings consist of materials with good environmental qualities. The laboratoy buiding has a slightly better rating than the accommodation which results from the use of the steel frame.

Point F is not fully applicable to this project as it requires specifications of the construction process with water, waste and energy reductions. This design is based on a prefabricated construction which helps to limit water and energy use and avoids on- and off-site waste production.

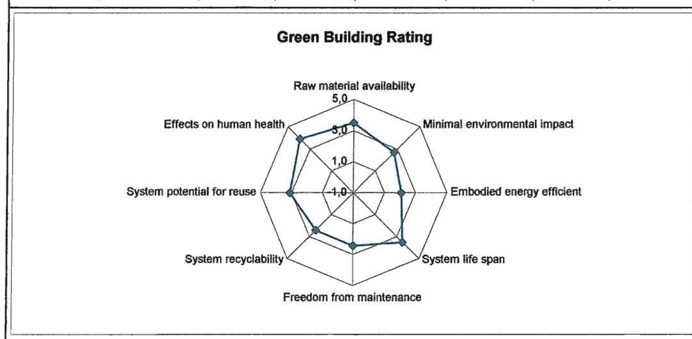
Tab.8_
Material Rating> Accommodation @HIRS

Elements	Specification	Raw material availability	Minimal environmental impact	Embodied energy efficient	System life span	Freedom from maintenance	System recyclability	System potential for reuse	Effects on human health	
Substructure	stainless steel screw-pile footings									
Rating		4	2	2	4	2	4	5	4	27
Primary structure	steel frame, CHS columns, C-section joists									
Rating		4	2	2	4	2	4	5	4	27
Roof	steel roof framing, truss with CHS purlins, bracing and PVC membrane									
Rating		3	2	2	4	3	4	4	3	25
Ground floor	hardwood flooring									
Rating		4	4	2	3	2	1	3	5	24
Staircases	steel frame									
Rating		4	2	2	4	2	4	5	4	27
External walls	plywood sandwich panels							Assume non toxic paint/ low emmission paint		
Rating		4	4	3	4	3	3	3	5	29
Internal walls	none									
Rating		0	0	0	0	0	0	0	0	
Windows	aluminium frame with transparent polycarbonate glazing, insect screen									
Rating		4	1	2	5	4	1	4	3	24
Doors	plywood									
Rating		4	4	3	4	3	3	3	5	29
Internal screens	plywood panels, hardwood frame									
Rating		4	4	3	4	3	2	3	5	28
Floors finishes	hardwood flooring (local grown)							Assume non toxic paint/ low emmission paint		
Rating		4	4	2	3	2	1	3	5	24
Ceiling finish	insulated ceiling panels, plywood									
Rating		4	4	3	4	3	3	1	5	27
Wall finish	none									
Rating		0	0	0	0	0	0	0	0	
TOTAL		3,5	2,7	2,1	3,5	2,4	2,4	3,1	3,9	22,4

Elements	Rating
Footing	27
Steel structure	27
Roof	25
Hardwood floor	24
Staircases	27
Plywood panel	29
Windows	24
Doors	29
Internal screens	28
Ceiling finish	27
TOTAL	



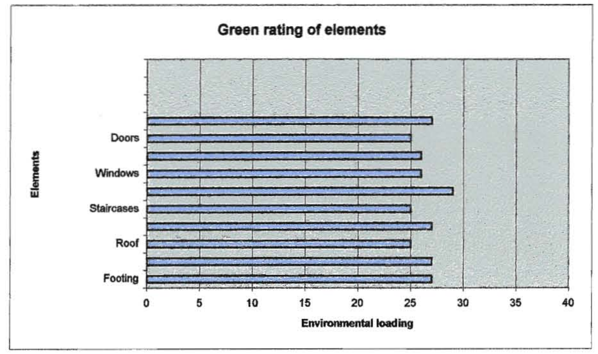
Raw material availability	Minimal environmental impact	Embodied energy efficient	System life span	Freedom from maintenance	System recyclability	System potential for reuse	Effects on human health
3,5	2,7	2,1	3,5	2,4	2,4	3,1	3,9



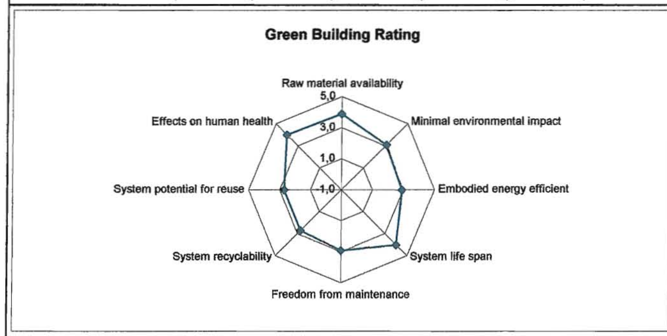
Tab.9_
Material Rating> Laboratory @HIRS

Elements	Specification	Raw material availability	Minimal environmental impact	Embodied energy efficient	System life span	Freedom from maintenance	System recyclability	System potential for reuse	Effects on human health	
Substructure	stainless steel screw-pile footings									
Rating		4	2	2	4	2	4	5	4	27
Primary structure	Laminated Veneer Lumber (LVL)									
Rating		4	4	4	4	3	4	1	3	27
Roof	steel roof framing, bracing and PV panels									
Rating		4	2	2	4	2	2	5	4	25
Ground floor	hardwood joists, plywood									
Rating		4	4	3	4	3	3	1	5	27
Staircases	Australian Plantation Grown Softwood									
Rating		4	4	4	3	2	2	1	5	25
External walls	plywood sandwich panels								Assume non toxic paint/ low emmission paint	
Rating		4	4	3	4	3	3	3	5	29
Internal walls	plywood sandwich panels									
Rating		4	4	3	4	3	3	3	5	29
Windows	aluminium frame with double glazed window									
Rating		4	2	2	5	4	2	4	3	26
Doors	Australian Plantation Grown Softwood									
Rating		4	4	4	3	2	2	1	5	25
Internal screens										
Rating		0	0	0	0	0	0	0	0	
Floors finishes	linoleum									
Rating		3	1	3	4	4	1	3	1	20
Ceiling finish	Insulated ceiling panels, plywood									
Rating		4	4	3	4	3	3	1	5	27
Wall finish	none									
Rating		0	0	0	0	0	0	0	0	
TOTAL		3,9	3,1	2,9	4,0	2,9	2,7	2,7	4,0	22,1

Elements	Rating
Footing	27
LVL	27
Roof	25
Flooring	27
Staircases	25
Plywood panel wall	29
Windows	26
Glass curtain	26
Doors	25
Ceiling finish	27
TOTAL	



Raw material availability	Minimal environmental impact	Embodied energy efficient	System life span	Freedom from maintenance	System recyclability	System potential for reuse	Effects on human health
3,9	3,1	2,9	4,0	2,9	2,7	2,7	4,0



Finally, **point G** comprises requirements that were of major interest in this project. To integrate all contextual parameters the design is based on a detailed site study. To create appropriate facilities that have minimum impact on Heron island's fragile eco-system and that enhance the user's understanding and interaction with the environment is the aim of this project.

Both projects are placed into an existing context of habitats and functional structures. Although contrasting in their function, scale, climatic requirements and user type, the buildings achieve integration through a common design idea which is to establish relationships between their environment and the occupants. According to Roger Stonehouse, a crucial characteristic for sustainable architecture is that it allows the occupant to live **with** the environment. He explains:

> ...we may see the re-establishing of more richly layered relationships between inside and outside [...] as essential to the creation of environments which are sustaining for individuals and socities and which are sustainable environmentally and culturally and enable us to dwell in and with rather than outside and against the environment. [1]

This statement stands in close correspondence to the theory of environmental education which asks people to rediscover their relationship with the earth.[2] It is a philosophical question of whether human beings want to see themselves as part of nature and accept the idea of equality.

The management of the Great Barrier Reef is based on this background and concentrates on two strategies: public participation and public education.[3] Informing people is essential to enhance their understanding of environmental problems which

[1] Roger Stonehouse, Dwelling with the Environment, Dimensions of Sustainability (London: E&FN Spon, 1998), p.131
[2] Andrew Jamison, The Making of Green Knowledge (Cambridge: Cambridge University Press, 2001), p.180
[3] Kathryn Jenkins, Environment Education in Practice: The Great Barrier Reef as a Significant Case Study, Environmental Education- imperatives for the 21st century (Albert Park: James Nicholas Publishers Pty Ltd, 1994), p.179

are directly related to their own actions. Self-regulatory behaviour based on consciousness of nature's importance for human life is the only way to achieve long-lasting success. Similarly, the effectiveness of an ecologically sustainable building always depends on responsible use by its occupants. This leads to the conclusion that architectural design which brings its occupants into a closer relationship with nature is a potential tool for environmental education.

Sustainable building on Heron Island implies not only different strategies for conservation, such as footprint minimization, prefabrication, renewable energies and passive design. It also needs to create space which allows communication between occupant and environment. The design project of this thesis provides two examples of how various strategies can be combined to establish an interpretative and sustainable type of architecture.

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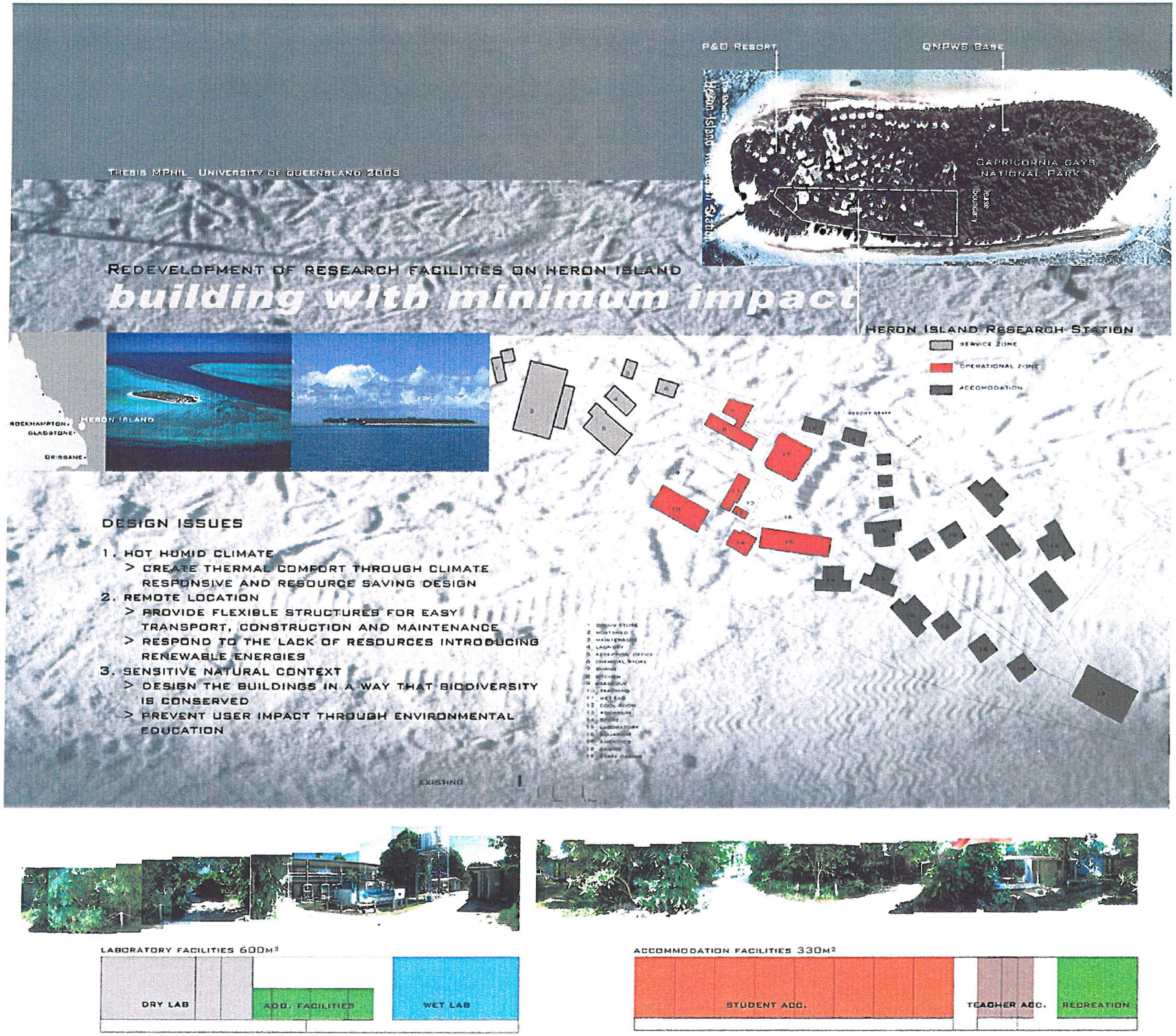
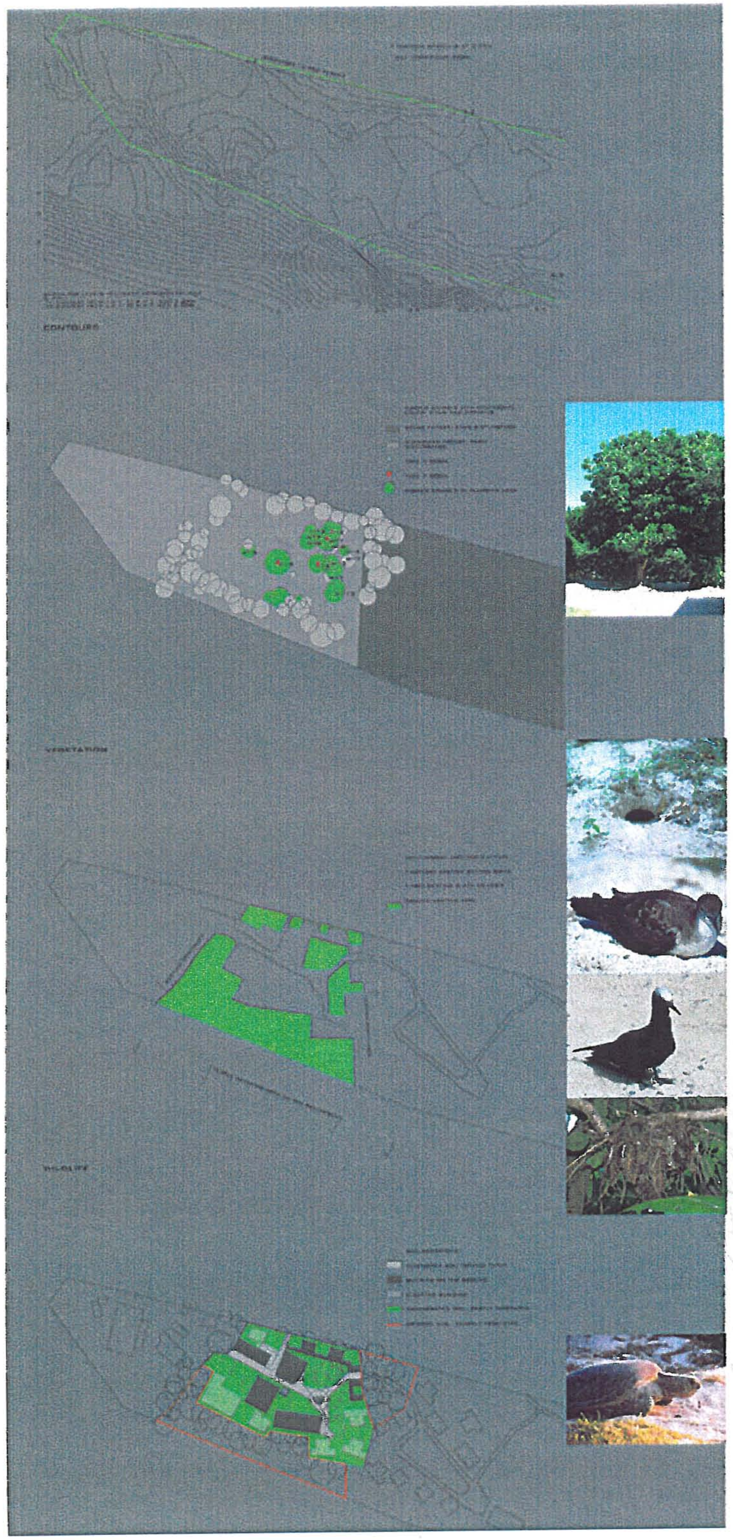
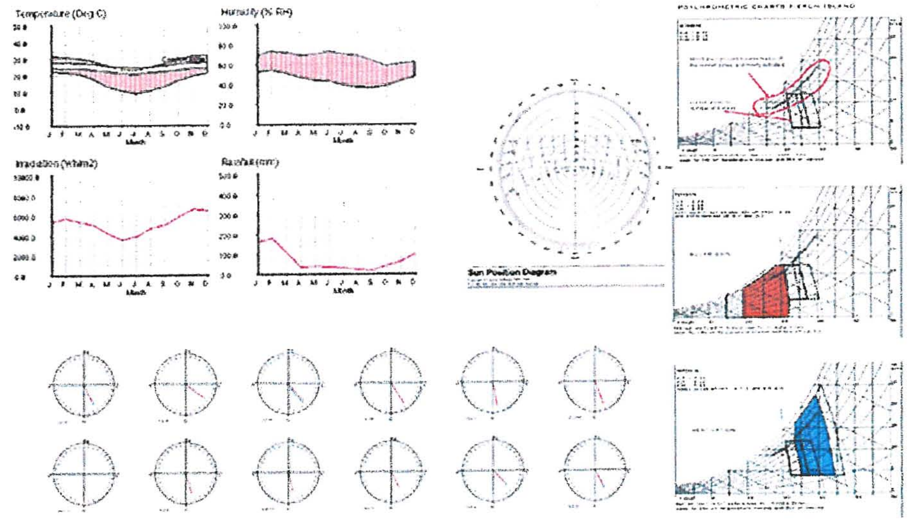
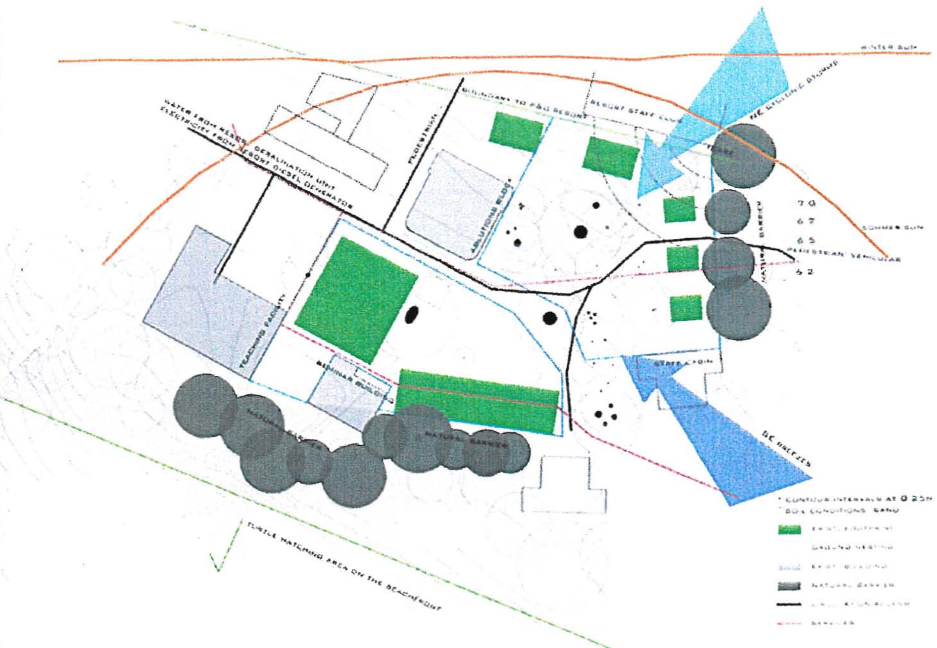
_ Appendices>


P&O Resort
QNPWS Base
Capricornia Cays
National Park
Lease
Boundary
Thesis MPhil_ University of Queensland 2003
Redevelopment of research facilities on Heron Island
building with minimum impact
Heron Island Research Station
Service zone
Operational zone
Accomodation
Rockhampton
Gladstone
Brisbane
Heron Island
Design Issues
1. Hot humid climate
> Create thermal comfort through climate responsive and resource saving design
2. Remote location
> Provide flexible structures for easy transport, construction and maintenance
> Respond to the lack of resources introducing renewable energies
3. Sensitive natural context
> Design the buildings in a way that biodiversity is conserved
> Prevent user impact through environmental education
Existing
Laboratory facilities 600m²
Dry lab
Add. facilities
Wet lab
Accommodation facilities 330m²
Student acc.
Teacher acc.
Recreation

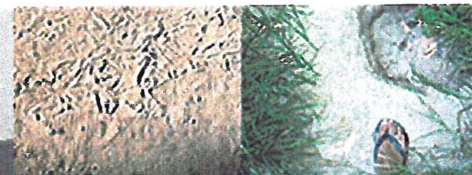




CLIMATE DATA



SITE ANALYSIS



reducing footprint

COMPACTNESS

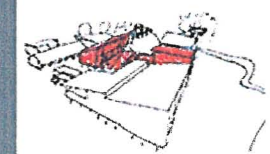
> INTEGRATION IN EXISTING CONTEXT

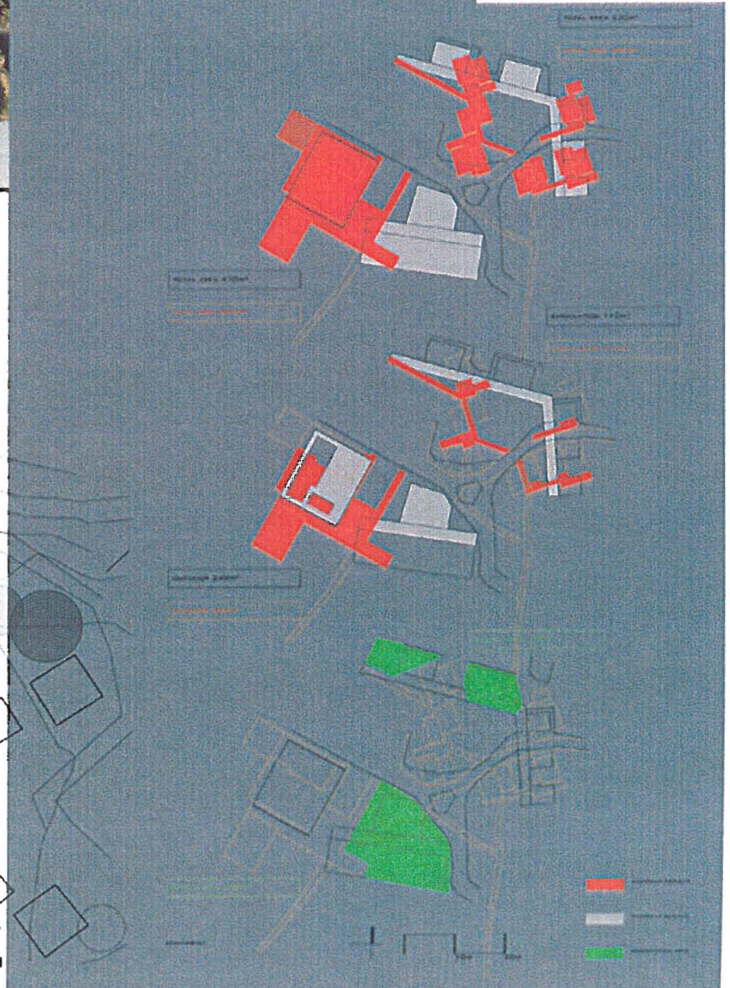
> HIGH DENSITY OPERATIONAL BLOCK

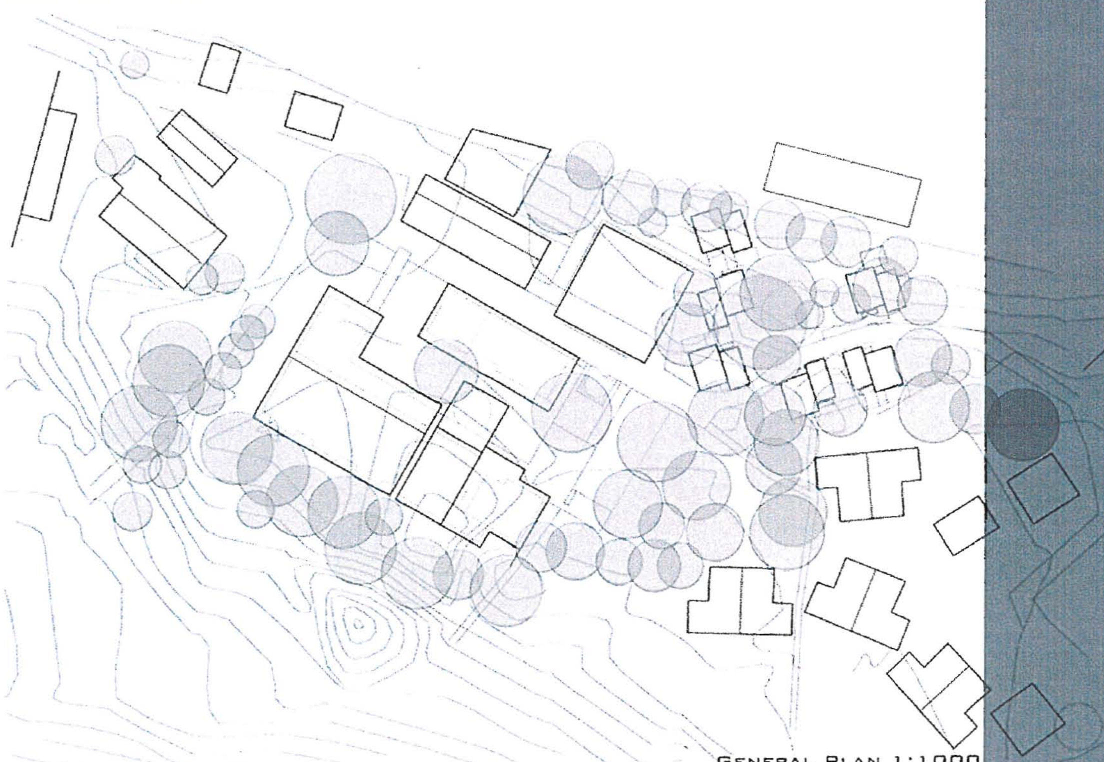
FRAGMENTATION

> SINGLE PAVILIONS LINKED BY ELEV. WALKWAY

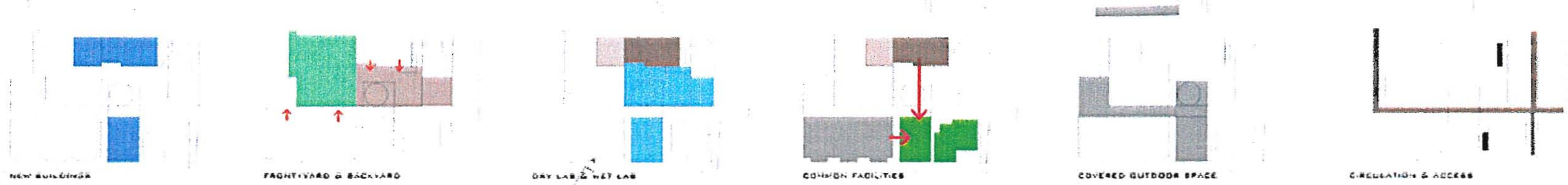
> AVOID LOADS OF MASS ON THE VEGETATED SITE



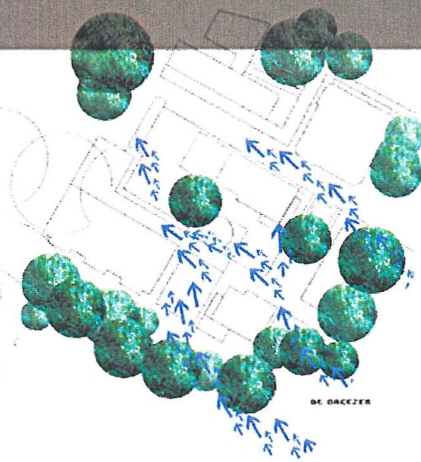




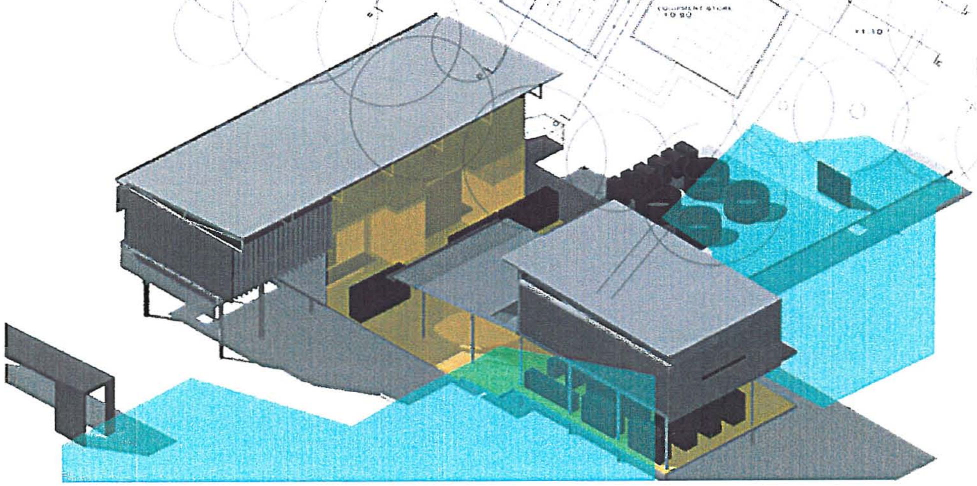
General Plan 1:1000

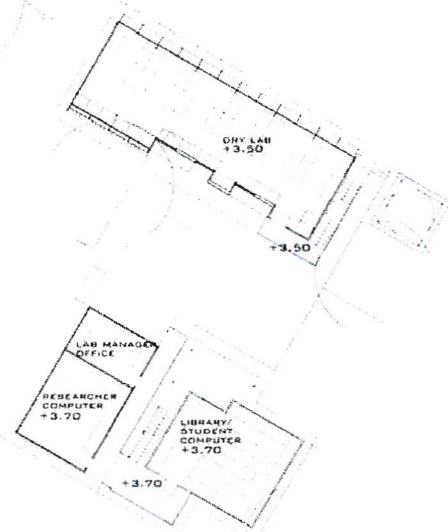


laboratory facility



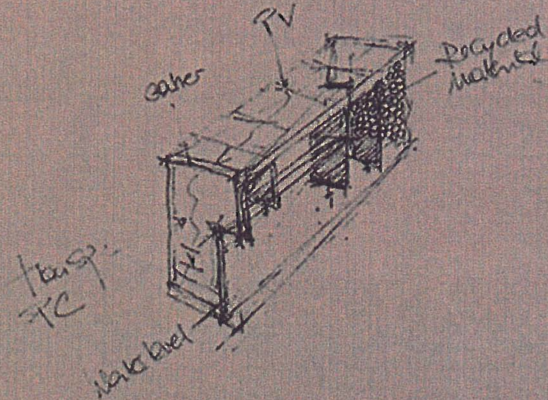
GENERAL PLAN LEVEL 0.60/0.80 _1:500





GENERAL PLAN LEVEL 3.50/3.70 _1:500

visitor circulation



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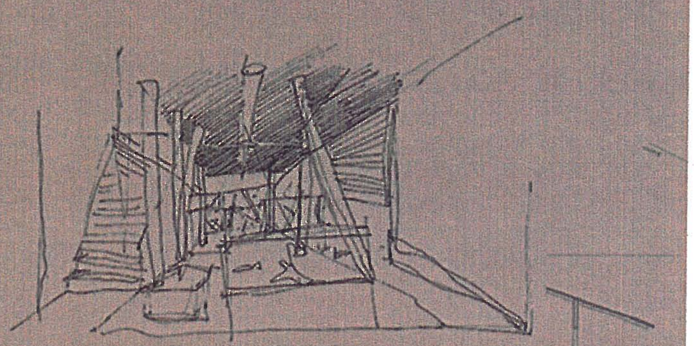
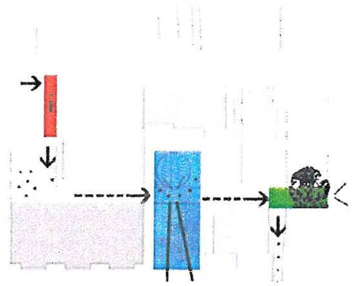
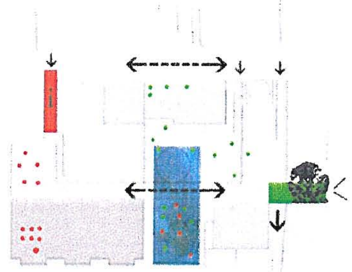


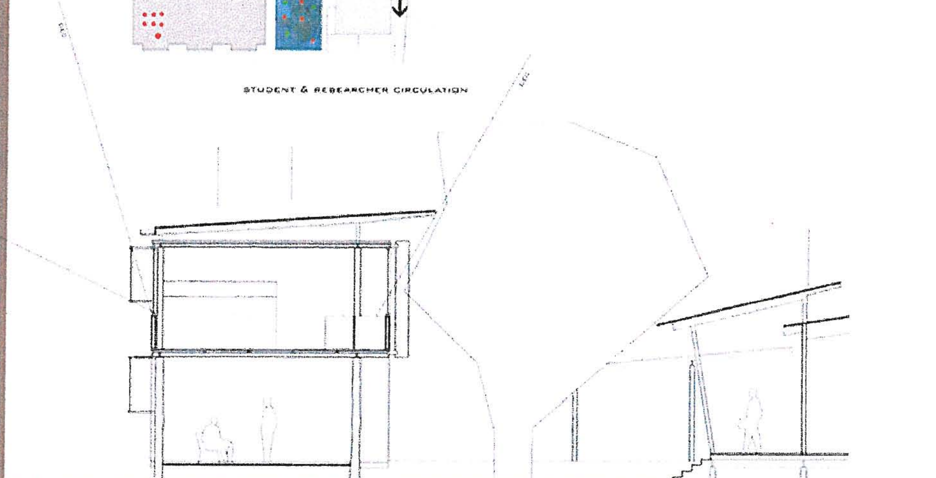
V



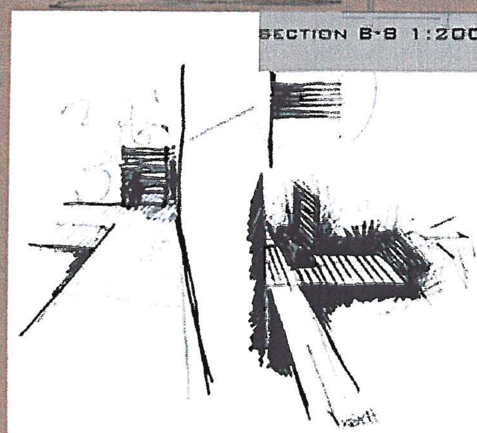
VISITOR CIRCULATION

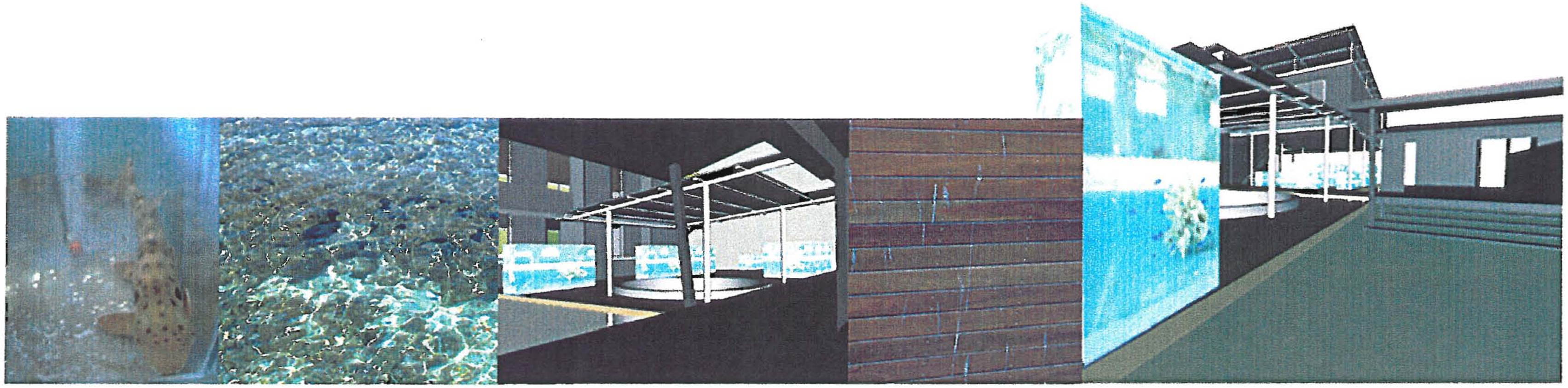


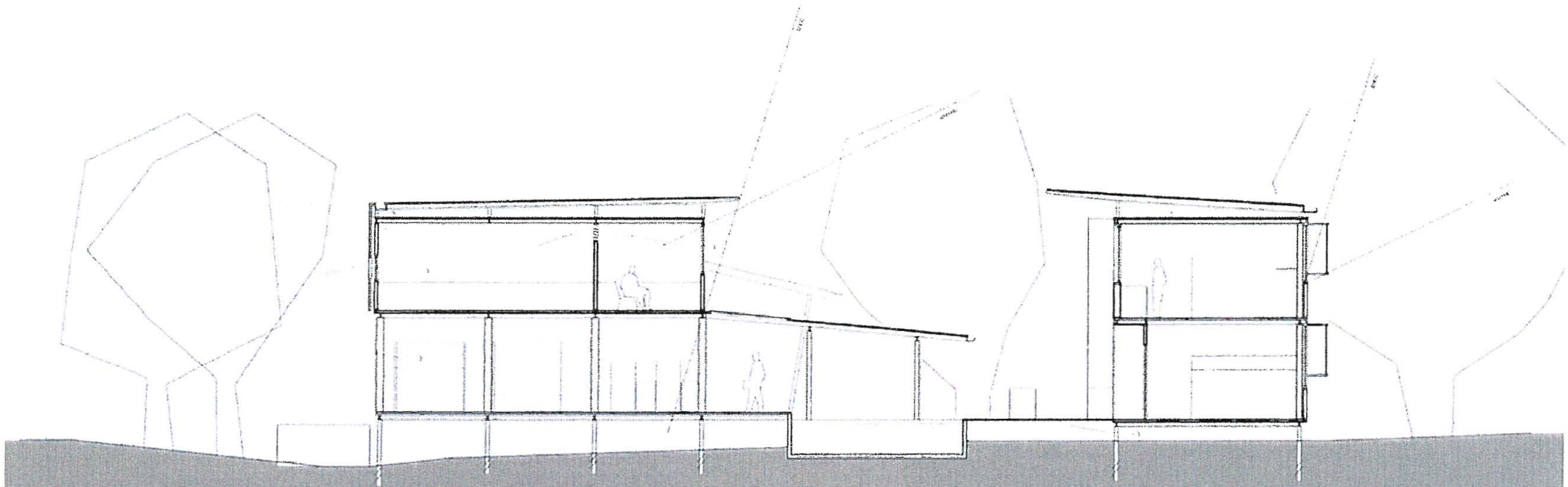
STUDENT & RESEARCHER CIRCULATION



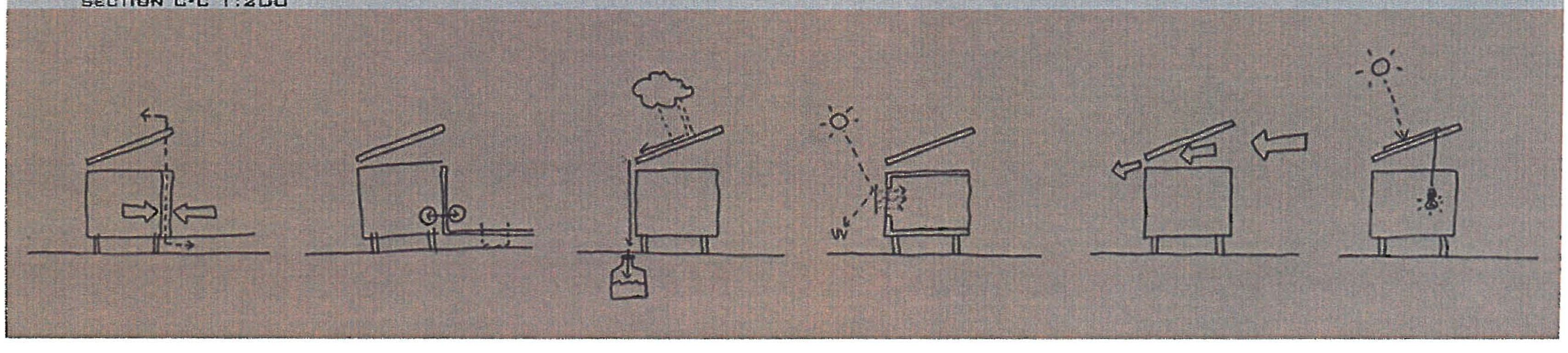
SECTION B-B 1:200

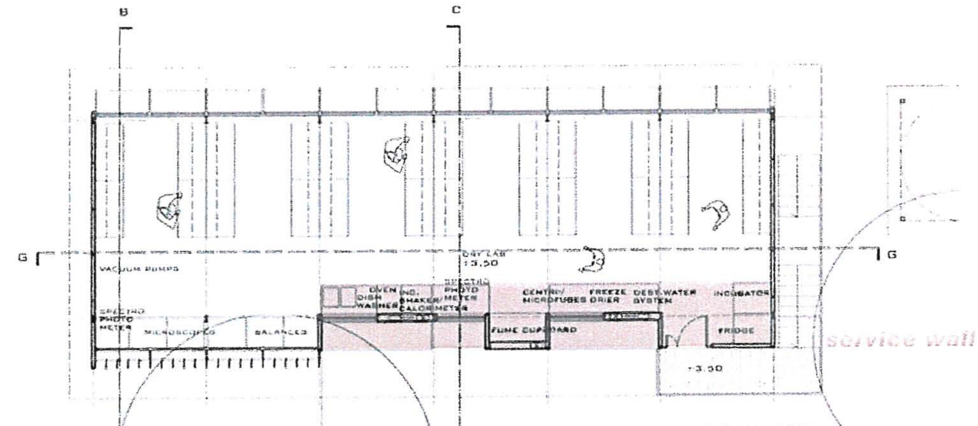




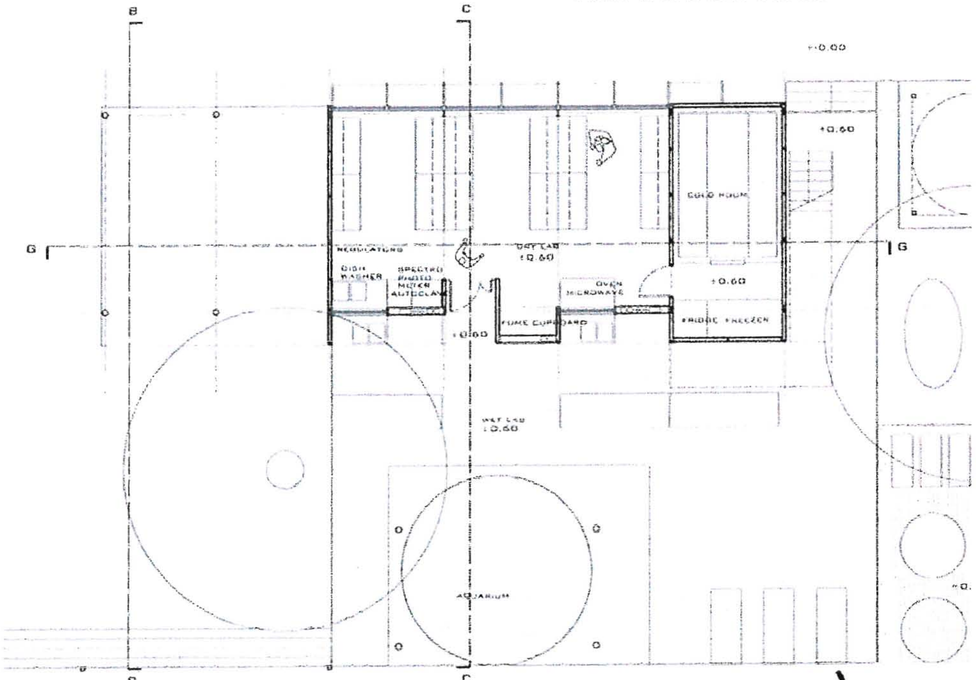


SECTION C-C 1:200

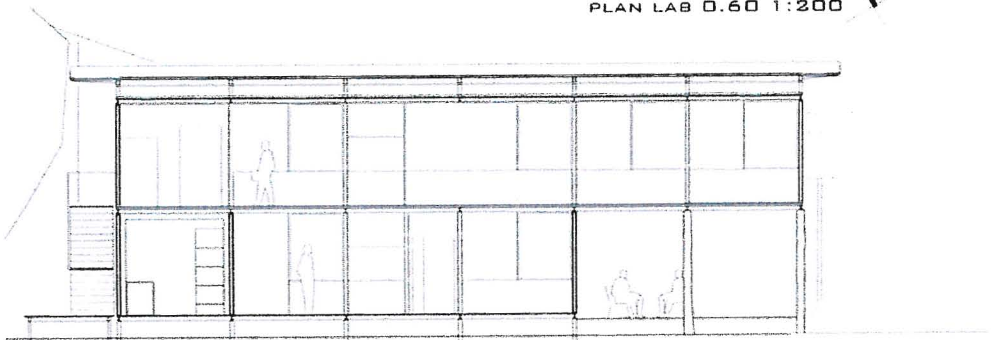




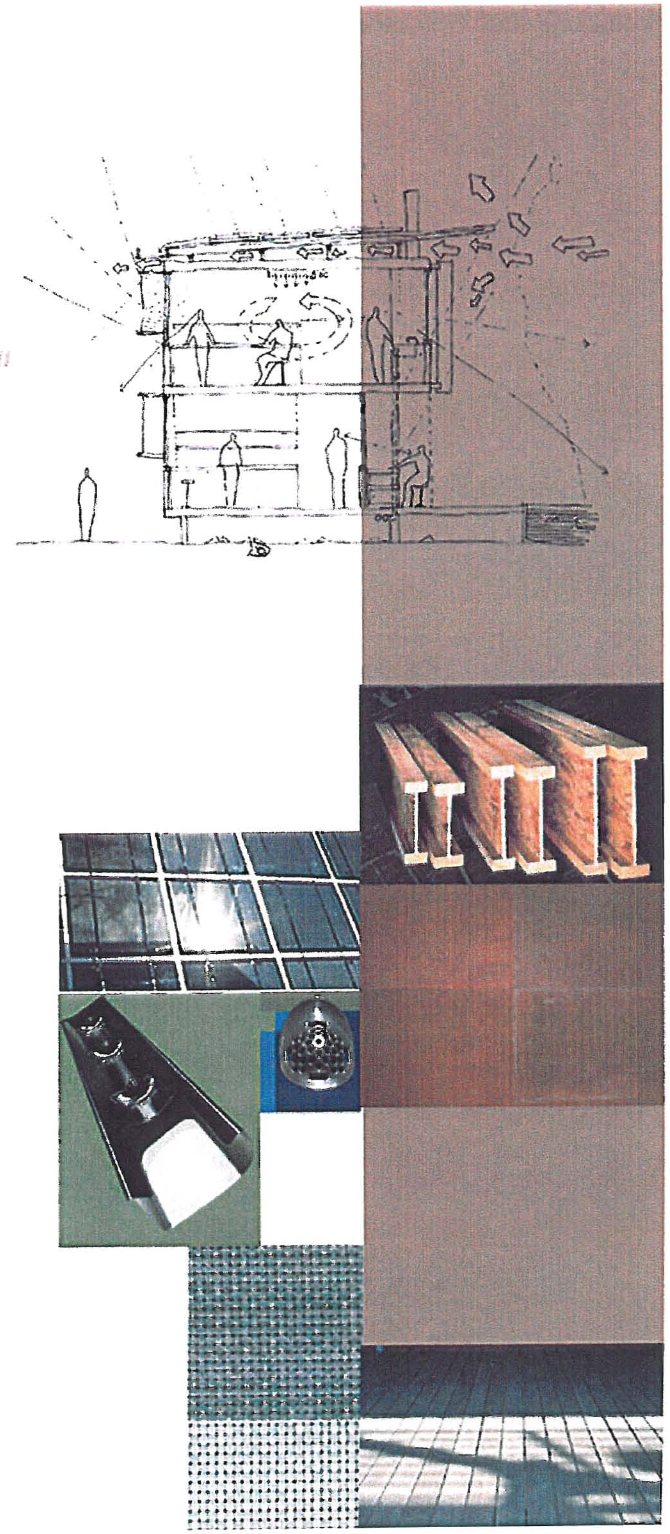
PLAN LAB 3.50 1:200

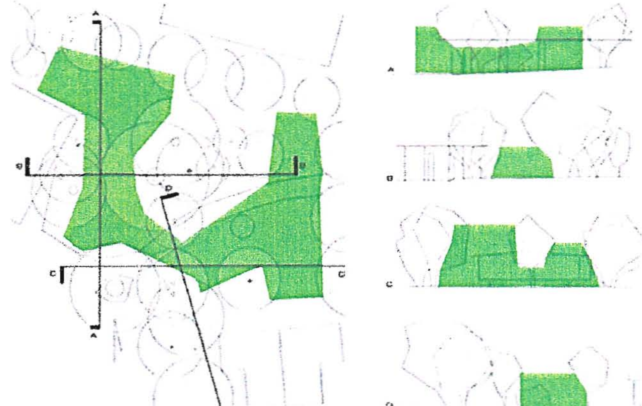


PLAN LAB 0.60 1:200



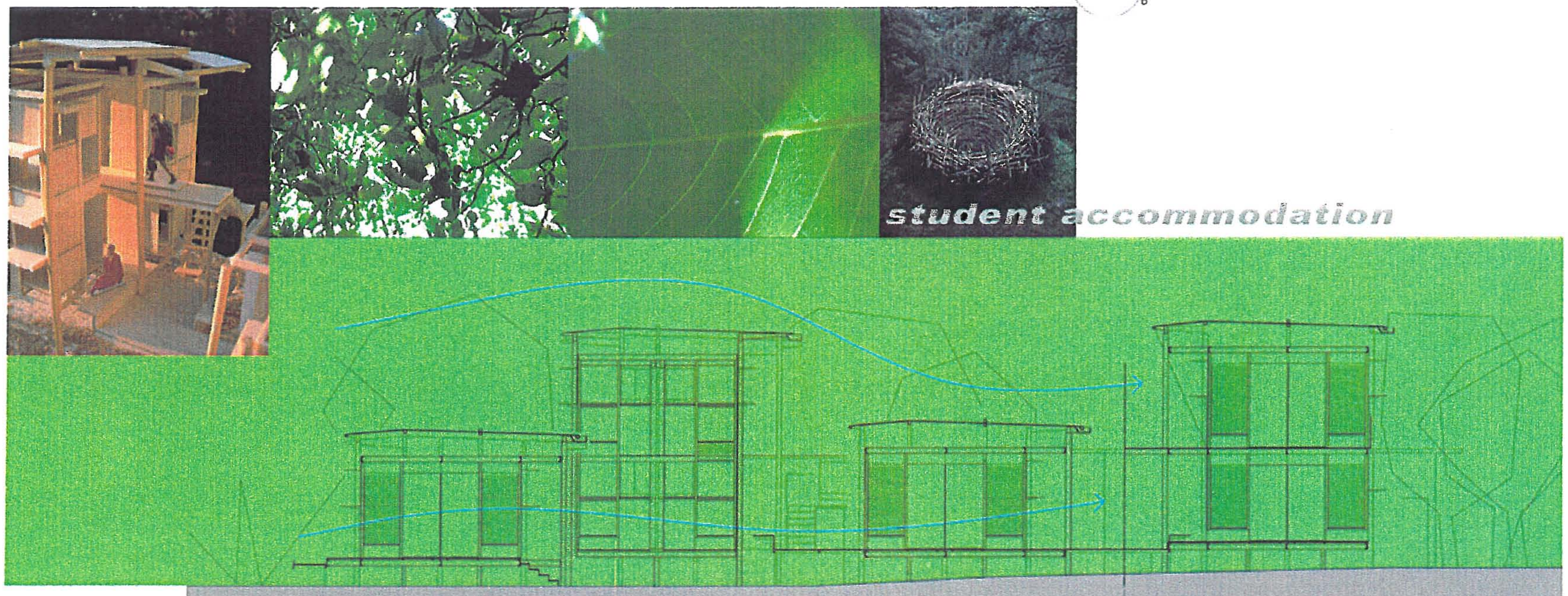
SECTION G-G 1:200



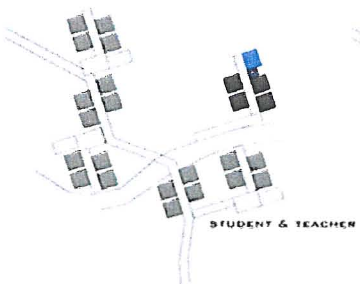


Natural clearing

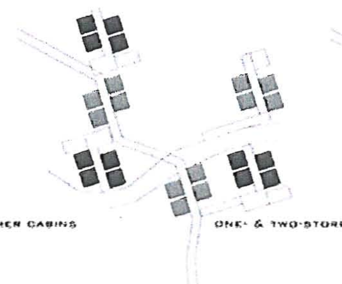
student accommodation



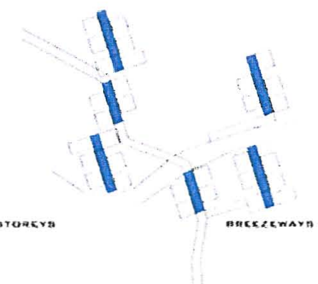
SECTION A-A 1:200



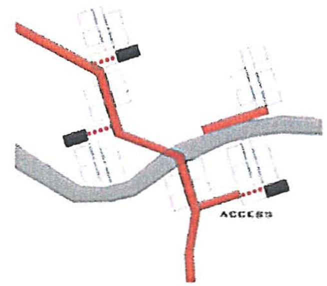
STUDENT & TEACHER CABINS



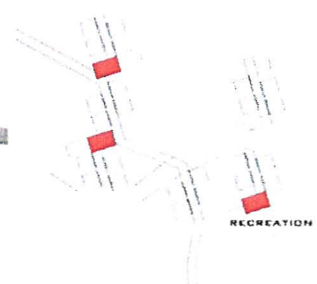
ONE- & TWO-STOREYS



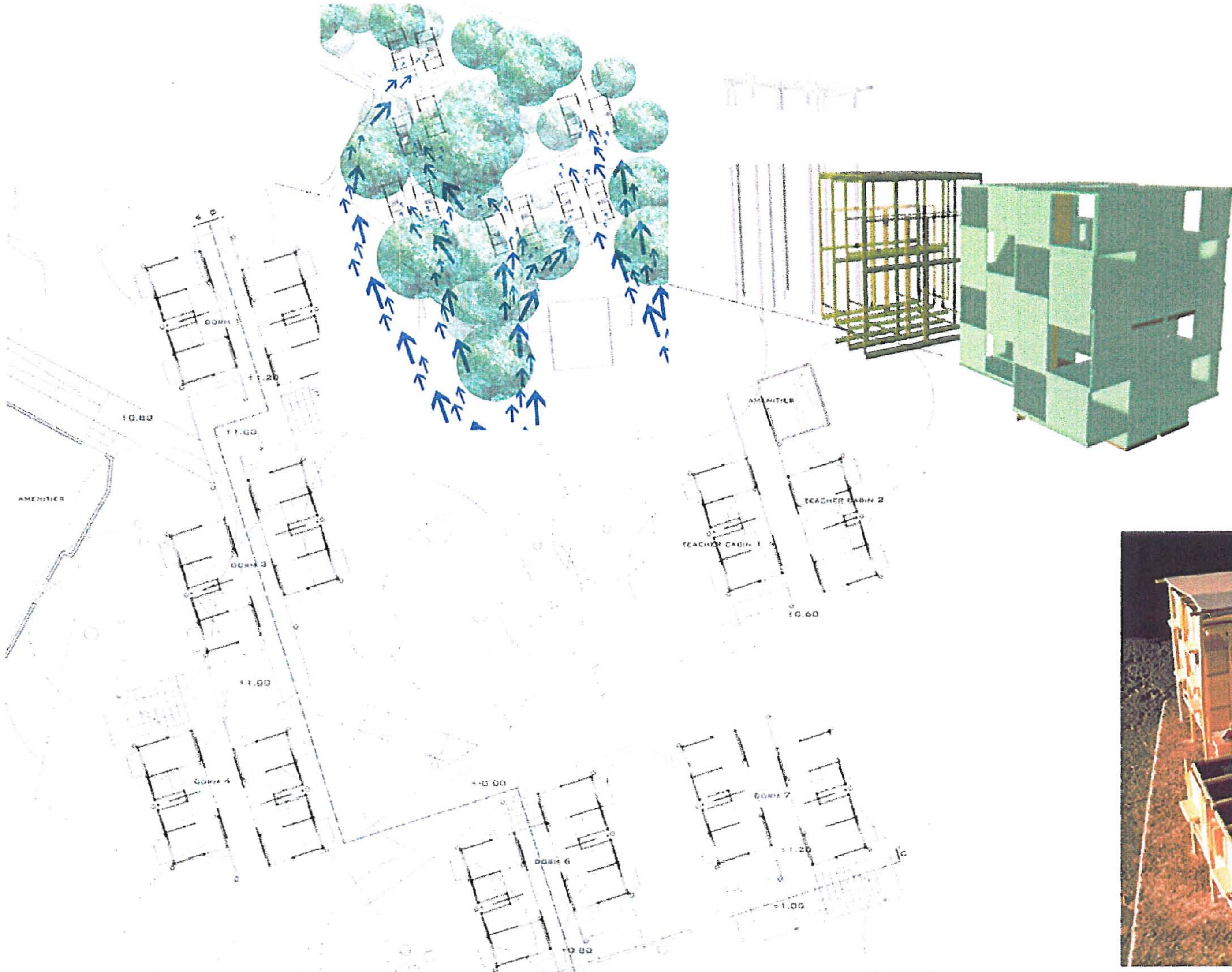
BREEZEWAYS



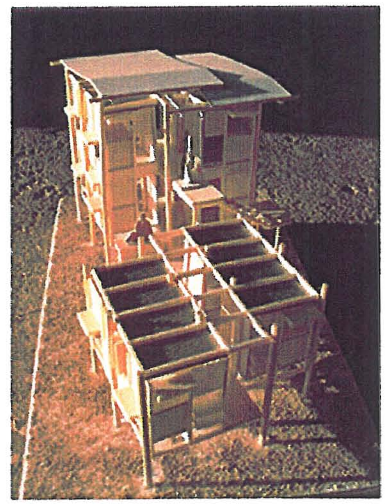
ACCESS

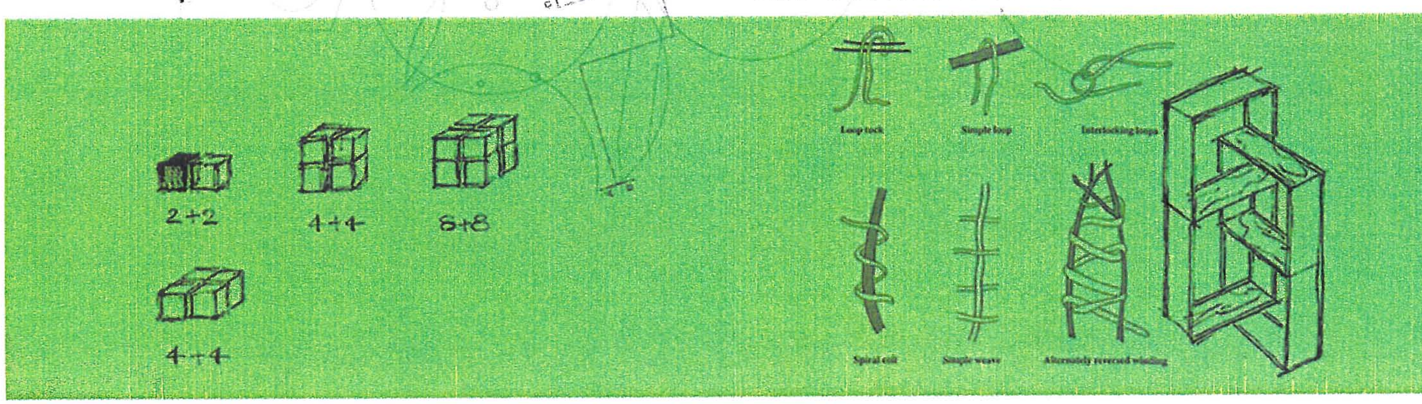


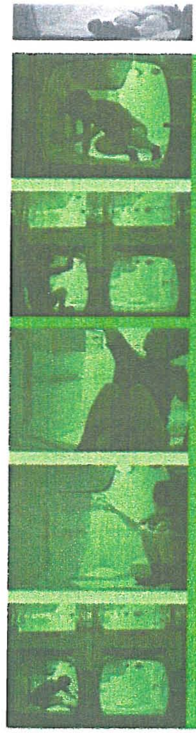
RECREATION

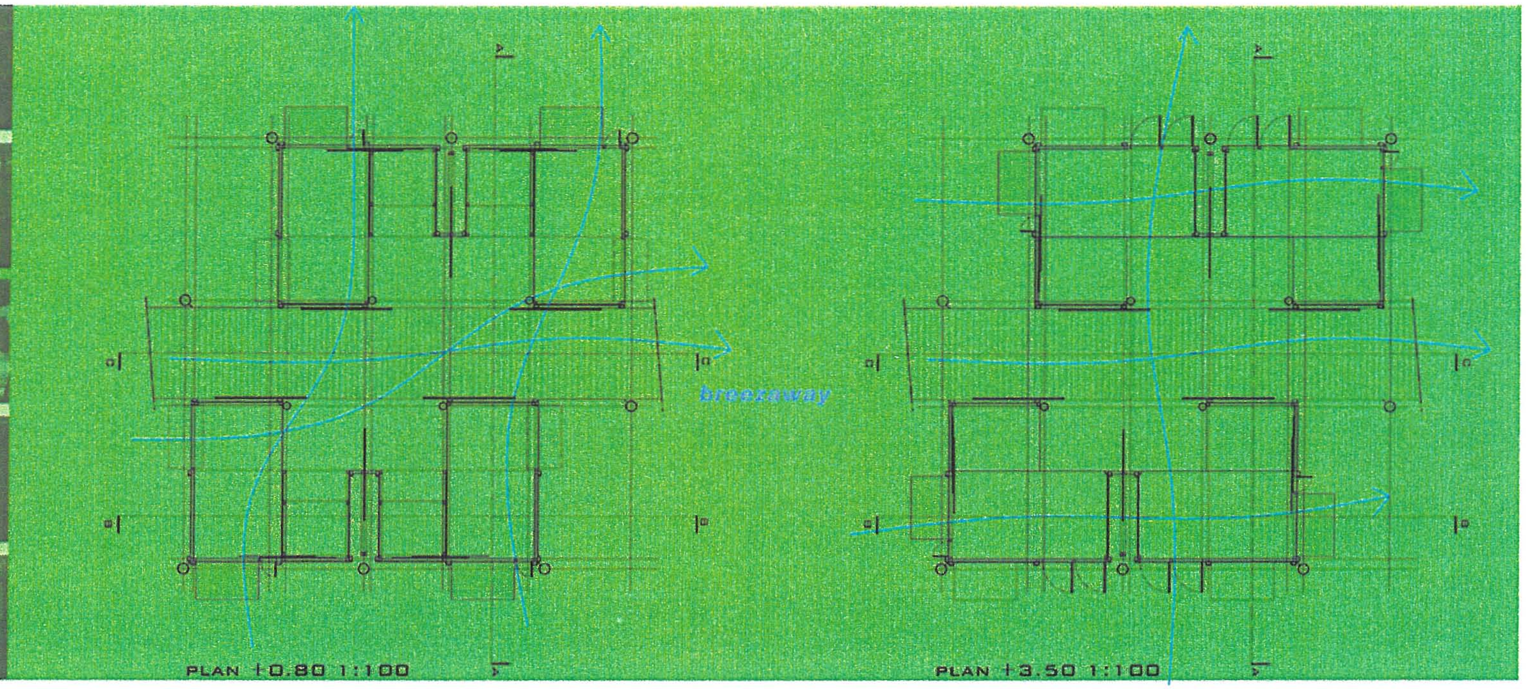


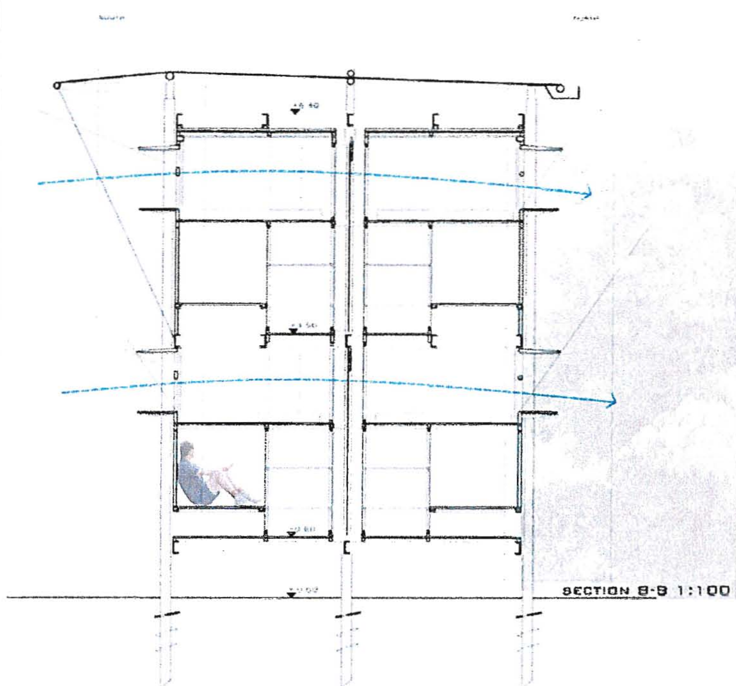
PLAN GROUNDFLOOR 1:200

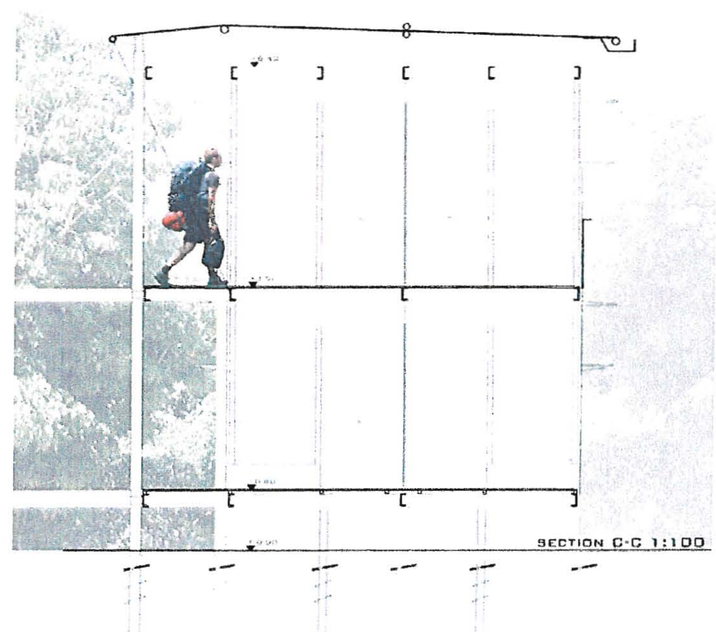


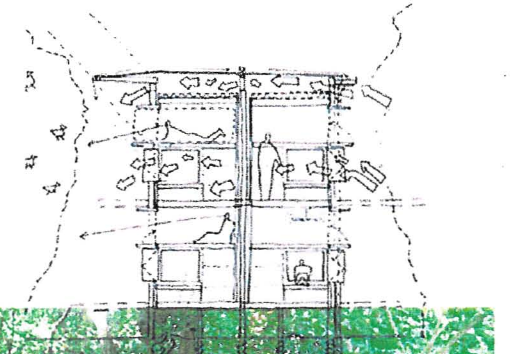


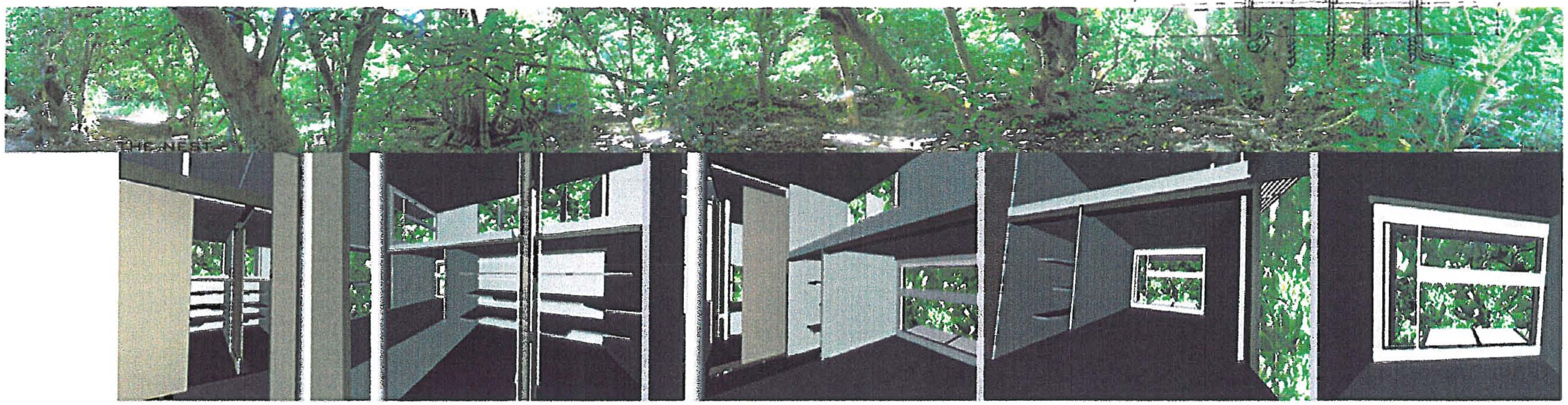


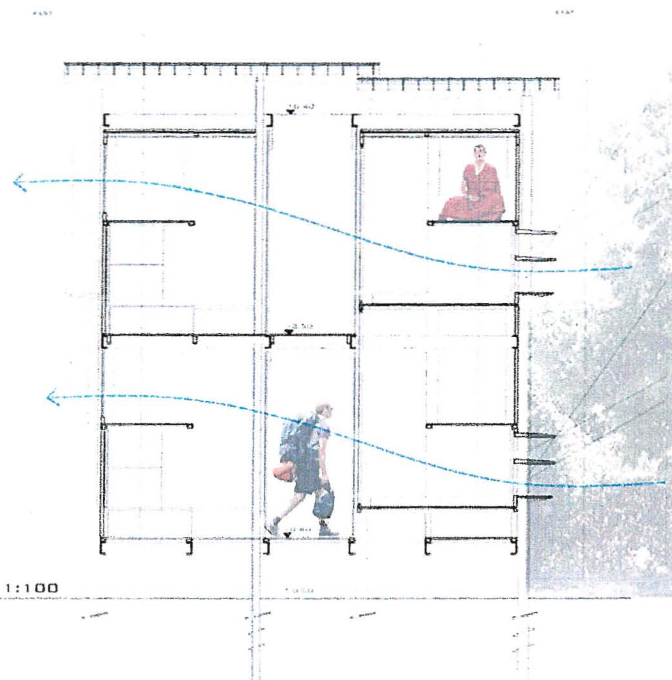

breezeway
PLAN +0.80 1:100
PLAN +3.50 1:100


SECTION B-B 1:100


SECTION C-C 1:100



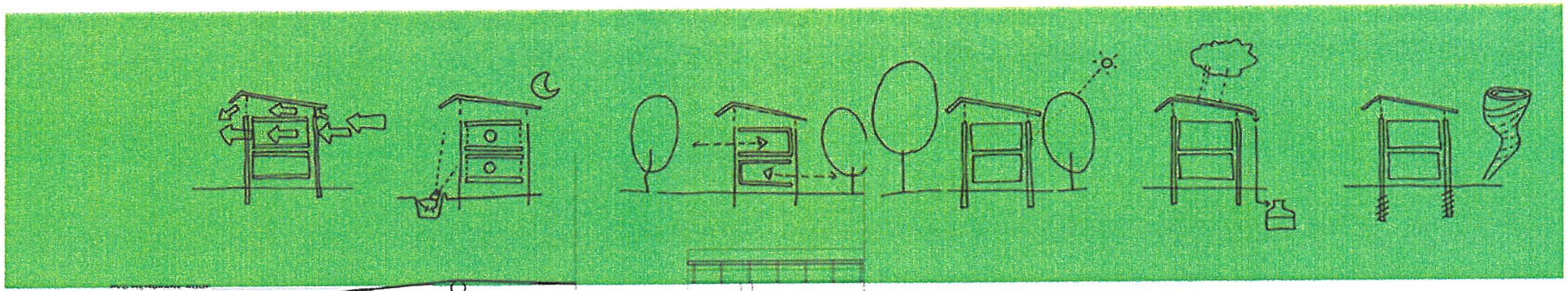


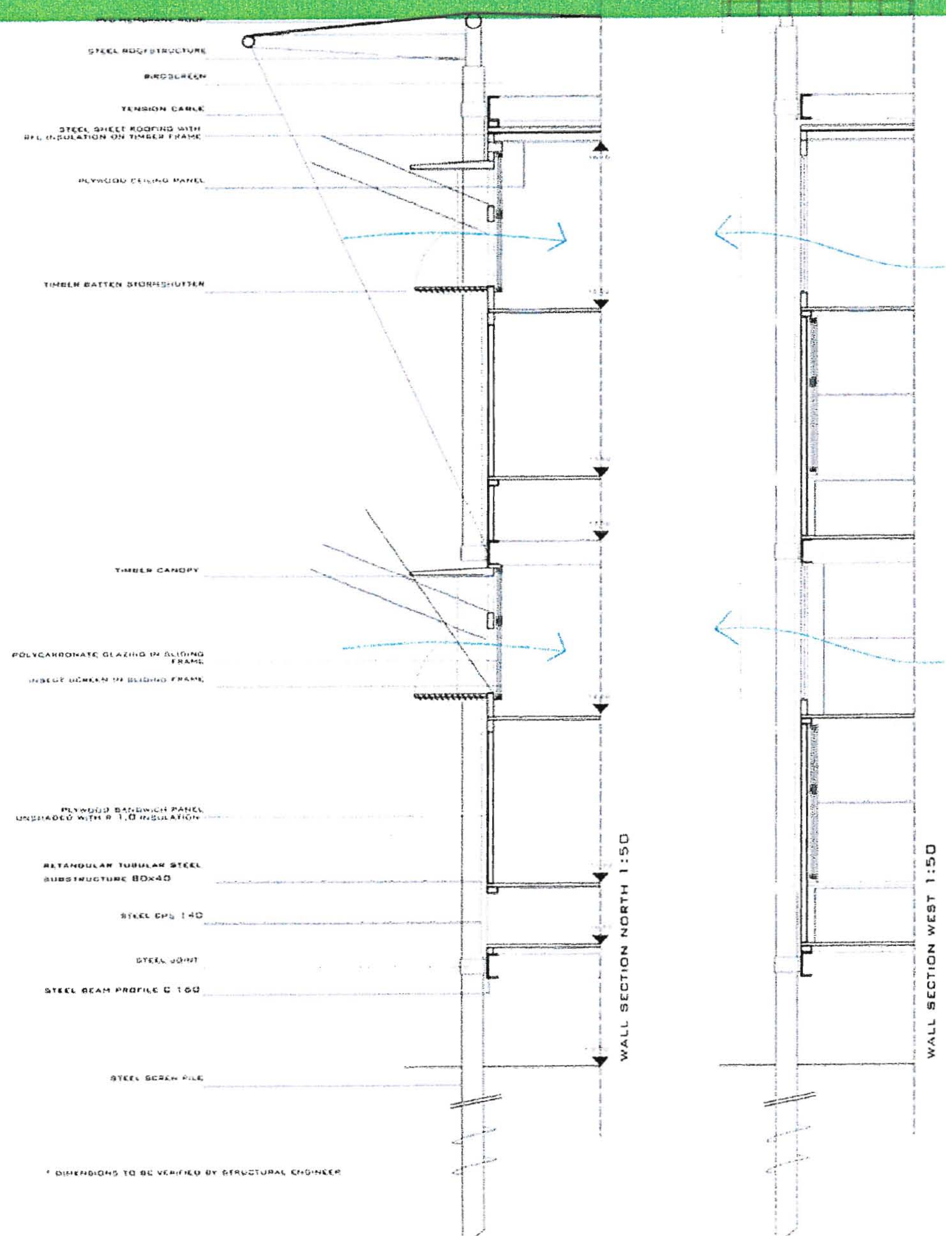


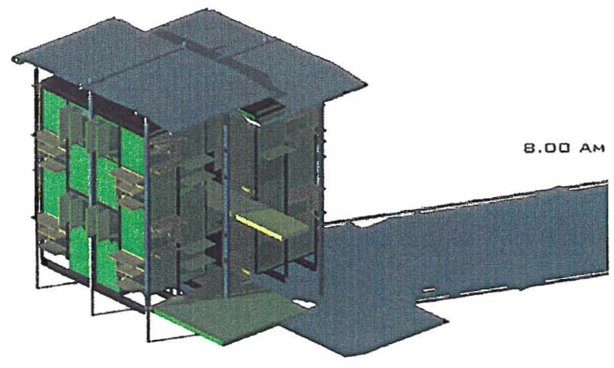
SECTION A-A 1:100

DESIGN IDEAS

> DORMITORY SPACE WITHIN THE TREES,
  EXPERIENCE THE SPACE SHARED WITH THE BIRDS
> NEST IMAGE
  - COMPOSITION: ROOF (LEAVES), SUPERSTRUCTURE (BRANCHES), SUBSTRUCTURE (NEST STRUCTURE), INFILL (NEST LINING)
  - BIRD NESTS CONSTRUCTION TECHNIQUES LIKE WEAVING AND INTERLOCKING
> PREFABRICATION
  BUNKMODULE WITH PRIVATE MINI COMPARTMENTS
> INTERACTIVE WINDOW DESIGN
> NATURAL VENTILATION




STEEL ROOFSTRUCTURE
BIRDSCREEN
TENSION CABLE
STEEL SHEET ROOFING WITH RFL INSULATION ON TIMBER FRAME
PLYWOOD CEILING PANEL
TIMBER BATTEN STORMSHUTTER
TIMBER CANOPY
POLYCARBONATE GLAZING IN SLIDING FRAME
INSECT SCREEN IN SLIDING FRAME
PLYWOOD SANDWICH PANEL UNSHADED WITH R 1,0 INSULATION
RETANGULAR TUBULAR STEEL SUBSTRUCTURE 80x40
STEEL CPS 140
STEEL JOINT
STEEL BEAM PROFILE C 160
STEEL SCREW PILE
* DIMENSIONS TO BE VERIFIED BY STRUCTURAL ENGINEER
WALL SECTION NORTH 1:50
WALL SECTION WEST 1:50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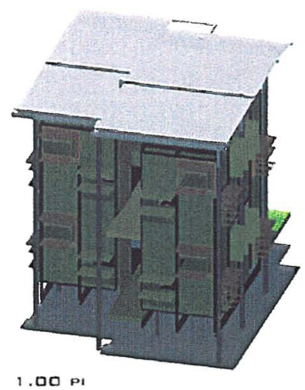
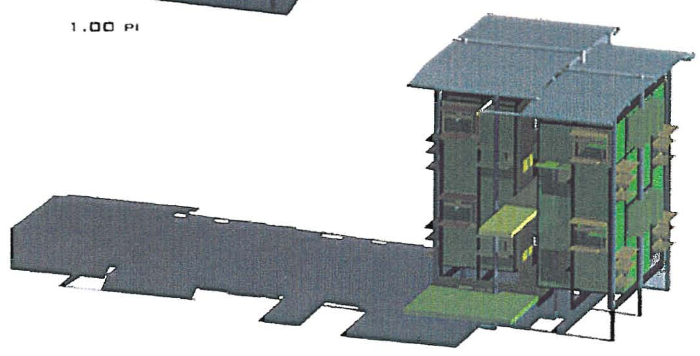
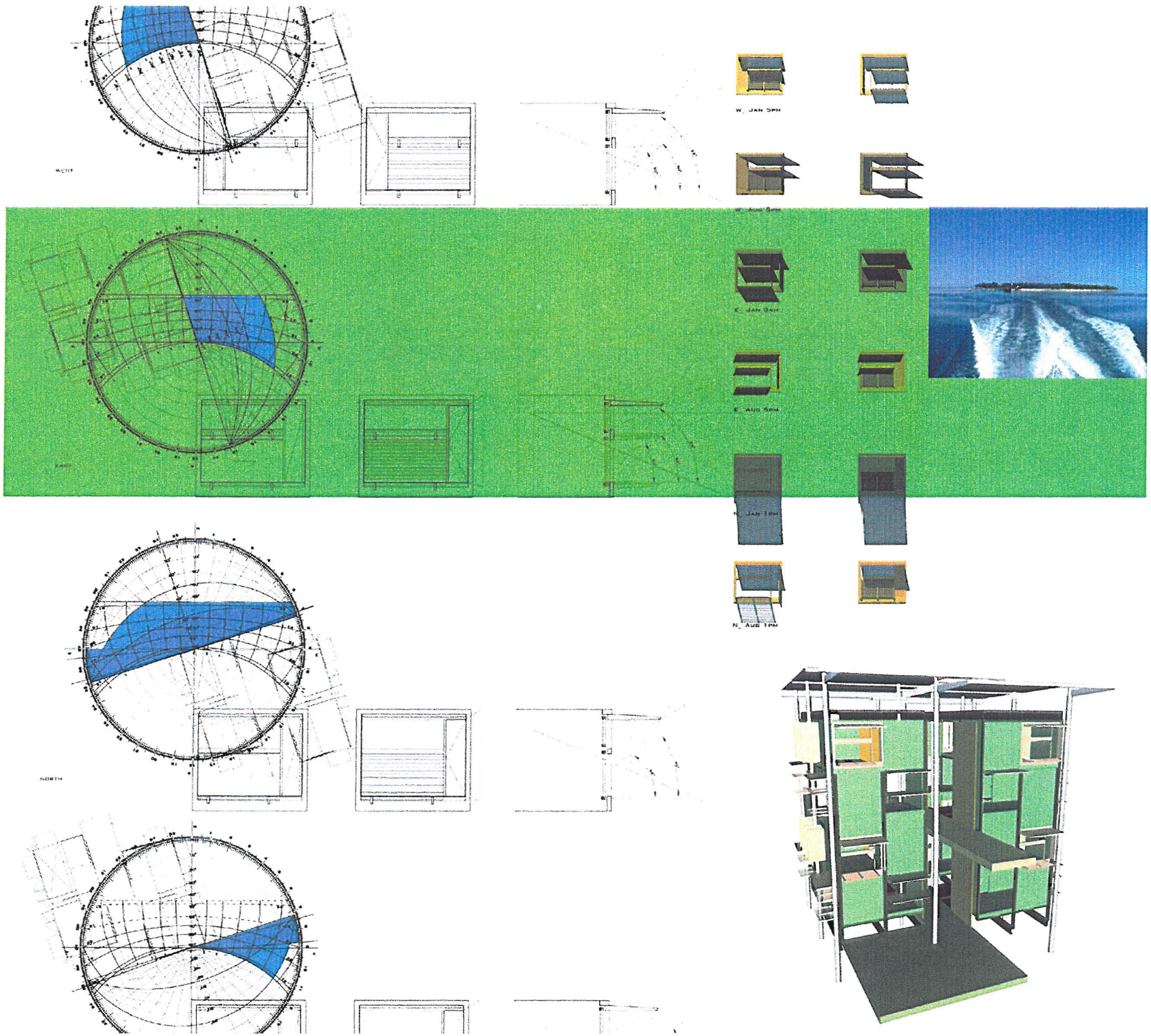

1.00 PI




W_ JAN 5PM
N_ JAN 1PM
N_ AUG 1PM